PROCEDURES & RESULTS OF BIOCHEMICAL OXYGEN DEMAND TESTS CARRIED OUT AT THE CROSSNESS LABORARORY 1990

SARAH CLARK

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PROCEDURES

Biochemical oxygen demand (BOD) tests were carried out for a number of reasons, and various techniques were employed. The following points highlight these:

1. At the start of the exercise river and effluent samples were tested using the Standard Method (2nd Edition, 1988). Dilution water was made up and used where necessary. The test however was not restricted to 5 days, but extended to 10 days, 20 days and 30 days (tables 1, 1A and 2). BOD tests were done using allylthiourea (ATU) and also without ATU, so that any nitrification occurring in the sample could be identified. Ammonia concentrations were also measured over the test period.

2. Table 3 shows results of BOD(ATU) tests performed on tideway river run samples. Once again dilution water was used, and the tests were carried out over 5 days only. For each zone, half the sample was filtered using a Buchner funnel and flask, and the other half was left unfiltered. This was done to see if suspended solids in the sample exerted an oxygen demand. The samples tested were those taken on a river run where the high tide was the highest for the month (spring tide). These tides are known to cause an increase in suspended solids in the Tideway.

3. Tables 4A and 4B show results of BOD tests with and without ATU to investigate nitrification in the upper Tideway zones. Table 4A gives results of tests using dilution water. Table 4B shows results of the tests using a different method without using dilution water. The 5 day test was carried out using 100 percent of the sample. The remaining sample left over from this test was stored in an open container in the incubator at 20 degrees C. After 5 days this remaining sample was aerated for 15 minutes and than a BOD bottle was set up using 100 percent of the sample (as with the 5 day test). The bottles were then placed in the incubator for a further 5 days. After this time the sample was tested in the usual manner for dissolved oxygen concentration. Therefore, in total this sample was a 10 day sample as 10 days had passed since the date of sampling. This method was continued for 15 and 20 days on each zone sample. This method was used to eliminate any errors caused by any longer term oxygen demand from the dilution water, and also because the

dilution water used in the Standard Method has an ammonium salt in the buffer, which might increase the BOD caused by nitrification.

4. Tables 5 and 6 give results of BOD tests with and without ATU of samples taken between Kingston and Teddington after high ammonia in Hogsmill STW final effluent entered the Thames. Table 5 shows results for Saturday 8.9.90 and Sunday 9.9.90 after high ammonia came into the Thames early Saturday morning. The results indicate the movement of the ammonia and any oxygen demand caused by nitrification in the river. Table 6 shows results for a similar occasion on 25.9.90. The BOD tests were, however, extended to 40 days. For results in tables 5 and 6 dilution water was used in the tests.

5. The results in table 7 are for tests carried out on river and effluent samples using dilution water as in tables 1-2, the only difference in the method being that the tests were extended to 40 days to investigate the longer term oxygen demands with and without ATU.

6. The BOD test results in table 8 are for 8 river and effluent samples where no dilution water was used and the technique explained in 3. above was employed over a 40 day period. For three of the samples, namely the River Thames at Teddington and Ravens Ait, and Kew STW, the BOD test was carried out using dilution to allow comparison with the no dilution water test. Again BOD with and without ATU tests were done to look at nitrification.

7. Tables 9 and 10 show results for samples tested without dilution water. Effluent samples taken on 1.11.90 were tested with and without ATU over 20 days, results of which are given in table 9. Ammonia concentrations in the sample were measured on days 0, 5, 10 and 15. Table 10 shows results for a survey carried out on the River Mole by the Guildford office. These BOD tests were undertaken to investigate any oxygen demand exerted by nitrifying bacteria along this stretch of the Mole, and result are included here for information.

Points of Interest from Results

1. All results show that there is some nitrification occurring in all bottled samples without ATU suppressing this process. In some samples a small amount of the oxygen demand is used in nitrification before 5 days, but in most cases the level increased between 5 and 10 days, and continues throughout the test period thereafter. Where ammonia is tested for there is also a drop in the concentration from day 0 with increased nitrification.

2. To summarise the results of river samples tested for BOD with and without ATU shown in tables 1 and 1A (figs. 1.1, 1.2 and 1A) the following points can be made:

   A. Nitrification is taking place in many of the bottled river samples, as can be seen by comparing ATU results with no ATU results. The Beverley Brook (which receives final effluent from Worcester Park STW) is a good example of this (see Figs. 1.1 and 1.2), and it can be seen that the 30 day BOD in the sample without suppression of nitrification is more than double that with ATU. Another example of this is for the Hogsmill River upstream of the River Thames, which is affected by Hogsmill STW. The rivers Wandle, Ravensbourne and Thames at Teddington did not show such a dramatic effect.

   B. Fig. 1A shows the results for 3 river samples and highlights the effects of ATU on the bottled samples. Once again, Hogsmill u/s Thames demonstrates a much larger BOD without ATU present in the sample, than that with ATU. Teddington shows this effect slightly after 15 days. Ravens Ait results show a decrease in BOD after 5 days which may be due to the increased dilution of the sample in the 10 day bottles; the dilution water causing a dilution of the number of bacteria present and so reducing the oxygen demand.

   C. In Fig.1.1, Teddington and Brent samples show a large increase in the BOD(ATU) at 30 days, which is possibly due to the fact that there were high levels of algae, especially in the Brent sample, at the time of sampling and some algae death may have caused an increased oxygen demand.

3. From Table 3 it can be seen that for zones 2-10, the filtering out of suspended solids causes the BOD(ATU) of the samples to be less, although the difference between these BODs and those for the unfiltered samples is not significantly larger. The suspended solids in this part of the Upper Tideway are probably from sewage effluents entering the tidal Thames rather than in increase caused by Spring tides. Where it is expected that the Spring tides would exert an effect further down the tideway, little difference between the filtered and unfiltered BODs has been observed.

4. The results for tests on samples from the upper tideway show that the greatest oxygen demands are exerted in the upper zones. Table 4A (Figs. 4Ai and 4Aii) results over 15 days indicate zones 3, 4 and 5 to have the largest BODs. There is also a difference between the results with and without ATU. Those without ATU are larger, especially after 5 days, demonstrating that some nitrification is occurring in the bottled samples. The elevated demands exerted in these upper zones 3, 4 and 5 are probably due to Mogden's effluent and perhaps from ammonia loadings coming over Teddington Weir from the Freshwater Thames caused by Hogsmill STW. Figs. 4Bi and ii from table 4B show graphically the BODs over a period of 20 days. A similar effect is seen here for samples tested without dilution water, but the 20 day results show even greater demands with and without ATU. The zones exerting the greatest demands are 3, 4 and 6, 7. Again these BODs are likely to be caused by loads from Teddington affecting zones 3 and 4, and Mogden STW affecting zones 6 and 7. The use of dilution water appears to have little effect on the results obtained.

5. High levels of ammonia entered the Thames on 8.9.90, caused by Hogsmill STW and its progress from Kingston to Teddington has been monitored by undertaking BOD tests on samples from various points in between. From Figs. 5A and 5B it can be seen that those samples tested without ATU have much higher BODs than those with ATU and this is due to nitrification of ammonia in the test bottles. In Fig. 5A on 8.9.90, the highest BOD was seen at the Kingston Tennis Court sampling point, and this corresponds to the highest ammonia concentration recorded in this sample (3.05 mgl^{-1}). Tests on samples from the following day on 9.9.90 show the highest BODs are for those points between Lower Ham Road parting from the river and Teddington and once again this corresponds to the highest ammonia

concentrations, and show how the plug of ammonia has moved downstream.

6. Figs. 6A and 6B show the results from table 6 of ammonia in the River Thames on 25.9.90. The most noticeable point to highlight from these graphs is the large jump seen in some of the samples where the BOD was tested at 29 days (rather than 20 days) compared to those tested at 30 days. The 29 day bottled samples were diluted to 18%, and the 30 day bottles to 9%. It would appear that there has been some form of suppression of the BOD with 18% dilution. All the tests on the samples used dilution water and therefore any errors, or oxygen demand in the dilution water will dramatically affect the results. This may be the cause of a decrease in oxygen demand at 30 days in sample 307, 311 and 316. On the whole it can be seen that those samples without ATU have much higher BODs than those with, and the sample from where Lower Ham Road meets the river had the highest ammonia concentration when tested and has the highest BOD with and without ATU. The oxygen demands at 40 days are much higher than would be expected with the concentrations of ammonia present, and few of the samples, especially those without ATU appear to have reached their ultimate oxygen demand.

7. The graphs for long term BOD for river and effluent samples in Figs. 7A and 7B demonstrate an expected pattern for BODs with and without ATU. The STW final effluent are likely to have a population of nitrifiers present and after 40 days the BOD without ATU are very much larger. Hogsmill river upstream of the Thames also demonstrates this due to the direct influence of the Hogsmill STW on this river. The large increase at 40 days may be as a result of death of nitrifiers in the sample due to reduction in food source and, as a consequence, an increase in activity of other bacteria so exerting a greater oxygen demand. The river samples show a leveling of the BOD (no ATU) at 30 and 40 days which indicates that the ultimate oxygen demand has been met. In the tests with ATU, the rivers show a similar pattern, but all the effluent samples and Hogsmill upstream of the Thames show a decrease in the BOD at 40 days. It is difficult to explain this occurrence, but possible causes may be that oxygen has entered the bottle and is meeting the oxygen demand (unlikely as only the effluent samples are affected); or that there is something in the samples that, after a long period, inhibits the oxygen demand.

8. Table 8 gives the results of various samples tested without dilution water, and results are represented graphically in Fig. 8Ai and 8Aii. Some interesting points can be raised from these graphs:

A. In all the samples tested, the BODs without ATU are higher than those with ATU, however the difference between the two are not as dramatic as demonstrated in tests with dilution water.

B. The 40 day BOD without ATU for Hogsmill STW is almost the same as the BOD with ATU, although the 10, 20 and 30 day result are more noticeably greater.

C. The 40 day BODs for Teddington and Ravens Ait are very similar to the 40 day BODs for Mogden STW and Kew STW, which is very interesting, and points to similarities in their ultimate oxygen demands.

D. Crossness STW final effluent was tested with different quantities of ATU, i.e. 0.5 ml and 1 ml. After 20 days the sample with less ATU had a higher BOD, and this would indicate that this amount of ATU is not completely suppressing nitrification. The standard method recommends the concentrations used in the 0.5 ml ATU sample, and therefore this suggests that some samples with high numbers of nitrifiers, as expected in Crossness STW and Hogsmill STW effluent, may require a greater concentration of ATU.

E. No dilution water was used and as can be seen there are no great fluctuations or problems with results as previously experienced, which would indicate that for long term BOD testing the use of dilution water is inadvisable.

Figs. 8Bi and 8Bii show results for three samples tested with dilution water and it is evident that errors in dilution water and any BOD it may exert, have caused problems with these samples and large fluctuations in the long term BOD are apparent. Few conclusions can be drawn from these graphs because of this, apart from reinforcing what has previously been stated in E above.

TABLE 1: B.O.D. WITH AND WITHOUT ATU FOR RIVER SAMPLES

DATE	RIVER SAMPLE	DILUTION % DAY (D)	BOD(ATU)	BOD	BOD - BOD(ATU)	NH3 DAY 0	NH3 DAY 2	NH3 DAY 4	NH3 DAY 5	NH3 DAY 10
25.7.90	WANDLE	100 5D	1.425	2.275	0.85	0.07			0	
		54 10D	0.9876	3.699	2.7114	0.07				0.02
		54 20D	2.985	6.156	3.171					
		27 30D	1.984							
	RAVENSBOURNE	100 5D	1.65	2.35	0.7	0.02			0	
		54 10D	0.896	0.675	-0.221	0.02				0.23
		54 20D	2.554	3.928	1.374					
		27 30D	9.318							
27.7.90	RAVENSAIT	100 5D	1.15	3.4	2.25					
		54 10D	4.328	5.657	1.329					
		54 20D	5.224							
		27 30D	6.16							
	TEDDINGTON	100 5D	3.1	3.85	0.75					
		54 10D	4.466	7.444	2.978					
		54 20D	4.399							
		27 30D	12.2							
	CRANE	100 5D	1	2.25	1.25					
		54 10D	3.504	6.391	2.887					
		54 20D	6.187							
		27 30D	7.05							
	BRENT	100 5D	8.35	10.175	1.825					
		54 10D	15.556	15.647	0.091					
		54 20D	15.947							
		27 30D	26.68							
	DUKE OF NORTH	100 5D	2.2525	3.65	1.3975					
		54 10D	4.191	5.566	1.375					
		54 20D	3.425							
		27 30D	5.79							
30.7.90	HOGSMILL	54 5D	2.337	8.559	6.222	1.26			0.74	0.36
	@ CLATTERN BR	27 10D	3.547	19.132	15.585	0.63				
	HOGSMILL	54 5D	1.606	6.181	4.575	0.36			0.2	0
	@ VILLIERS RD	27 10D	1.438	13.081	11.643	0.18				
	TEDDINGTON	100 5D	2.825	3.05	0.225	0.59			0.51	0
		54 10D	3.308	7.982	4.674	0.24				
10.8.90	MOLE US HORLEY STW	54 5D	6.649	8.574	1.925					
	MOLE @ KINNERSLEY	54 5D	4.907	18.563	13.656					
	MOLE @ WICK FARM	54 5D	6.007	12.789	6.782					
	BEVERLEY @	27 5D	16.001	20.035	4.034					
	MOTSPUR	9 5D	7.75	27	19.25					
	HOGSMILL US	27 5D	2.25	15.268	13.018					
	THAMES	9 5D	0.005	22.6	22.595					

FIG 1.1: GRAPH OF RESULTS FROM TABLE 1 - BOD TEST - WITH ATU for RWER Samples

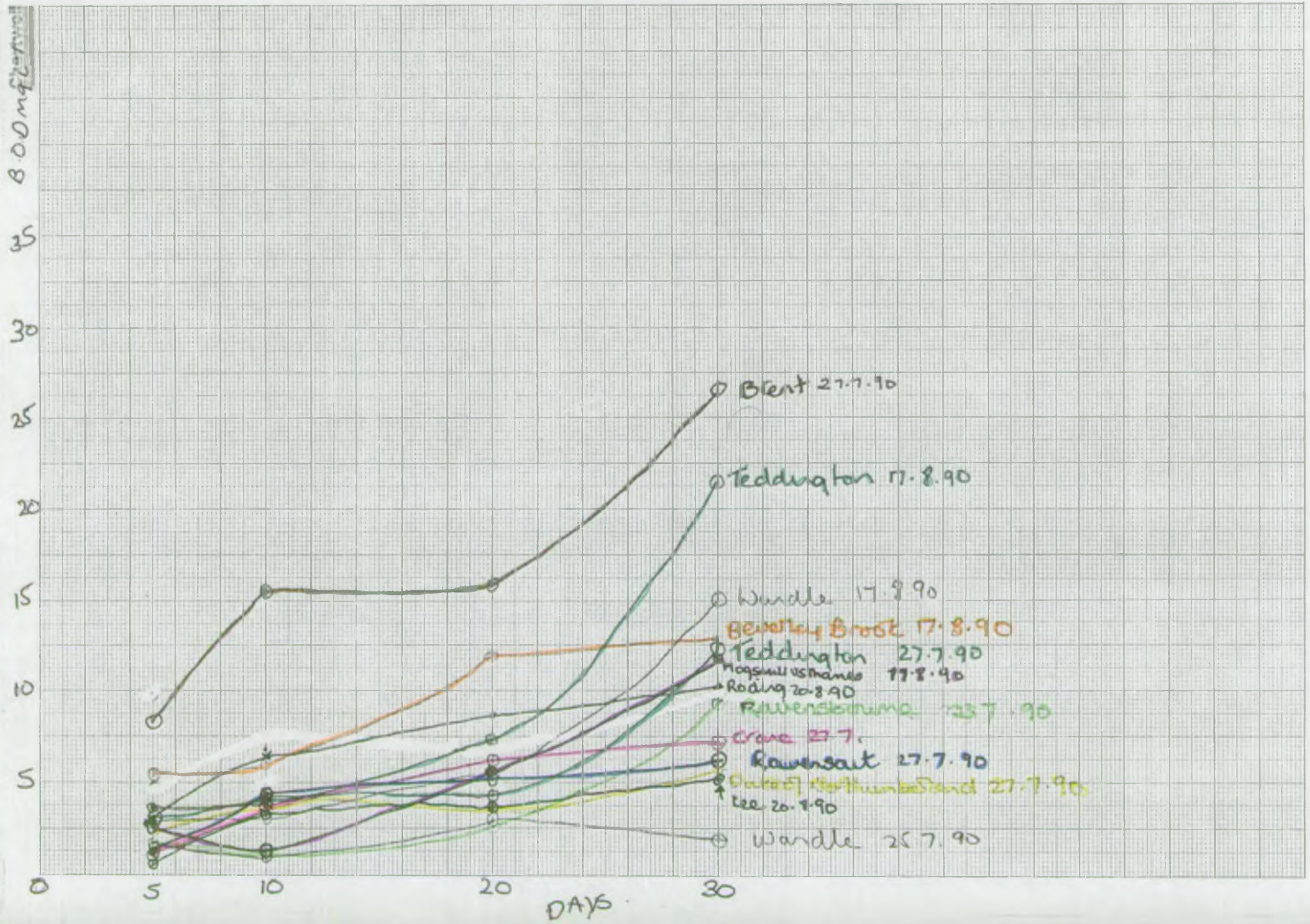


FIG 1.2: GRAPH OF RESULTS FROM TABLE 1 - BOD TEST WITHOUT ATU FOR RIVER SAMPLES

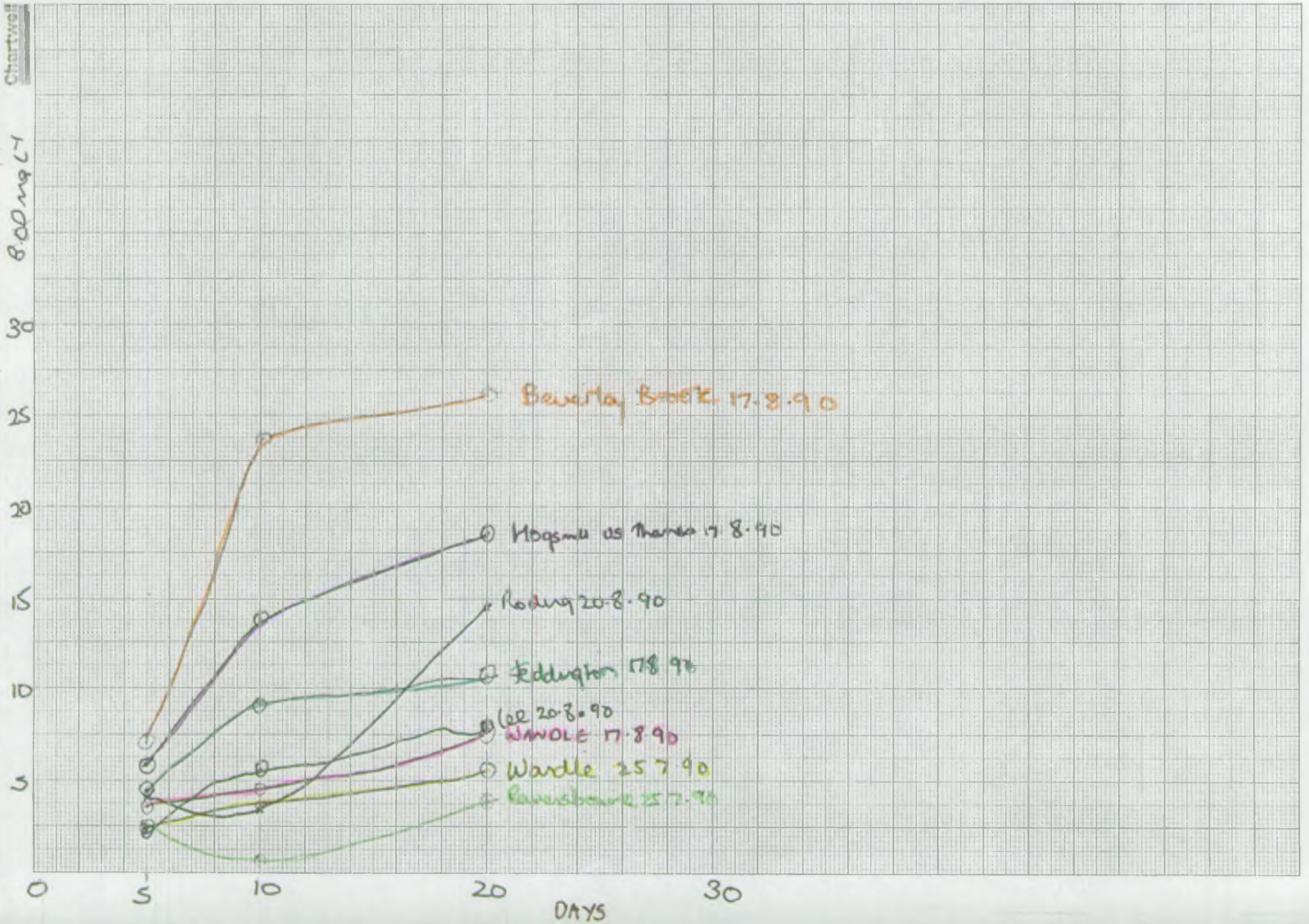


TABLE 1A: BOD WITH AND WITHOUT ATU FOR RIVER SAMPLES

DATE	RIVER SAMPLE	DILUTION % DAY (D)	BOD(ATU)	BOD	BOD - BOD(ATU)	NH3 DAY 0	NH3 DAY 2	NH3 DAY 4	NH3 DAY 5	NH3 DAY 10
17.8.90	WANDLE	100 5D	3	3.65	0.65	0.26		0.5	0.37	0.16
		54 10D	3.033	4.545	1.512	31		0.32	0.36	0.28
		54 20D	5.361	7.515	2.154					
		27 30D	15.238							
	HOGSMILL	100 5D	2.529	5.782	3.253	1.8		1.48	0.7	0.02
	US THAMES	54 10D	1.251	13.718	12.467	1.8		2.04	1.8	2
		54 20D	5.317	18.518	13.201	1.8		1.88	2.1	1.8
		27 30D	11.801							
	BEVERLEY	100 5D	5.37	7.065	1.695	5.3		4.5	5.4	3.5
	BROOK	54 10D	5.926	23.619	17.693	5.3		4.7	6.1	5.6
		54 20D	11.826	26.127	14.301	5.3		4.7	5.2	6
		27 30D	12.626							
	TEDDINGTON	100 5D	3.525	4.4	0.875	0.5		0.53	0.41	0.03
		54 10D	3.583	9.036	5.453	0.57		0.59	0.61	0.47
		54 20D	7.24	10.677	3.437					
		27 30D	21.426							
17.8.90	CRAWLEY	54 5D	1.928	4.219	2.291	5.1			5.5	5.6
		27 10D	5.317	18.06	12.743	5.1			6.6	5.4
	KINNERSLEY	54 5D	4.082	6.098	2.016	4.2			5.7	6.9
		27 10D	7.151	27.594	20.443	4.2			6.1	6.2
	KICK FARM	54 5D	4.082	9.764	5.682	5			4.1	4.8
		27 10D	7.243	26.219	18.976	5			5	5.1
	MOLE US HORLEY	54 5D	2.432	4.082	1.65	4.1			6.1	5.6
		27 10D	9.443	28.053	18.61	4.1			6.8	6.3
	MOLE US SAT	54 5D	5.09	6.739	1.649	0.2			0.51	0.19
		27 10D	9.993	14.576	4.583	0.2			0.07	0.1
20.8.90	LEE	54 5D	0.655	2.212	1.557	0.23		0.39	0.44	
		27 10D	3.267	5.559	2.292	0.18		0.15	0.16	
		27 20D	3.742	7.868	4.126					
		9 30D	5.025							
	RODING	54 5D	2.808	4.091	1.283	0.87		0.83	0.77	
		27 10D	6.476	3.451	-3.025	0.82		0.74	0.8	
		27 20D	8.693	14.559	5.866					
		9 30D	10.249							
4.9.90	TEDDINGTON	50 5D	4.475	3.025	-1.45					
		25 10D	7.45	7.95	0.5					
		25 15D	6.425	13.925	7.5					
	RAVENSAIT	50 5D	9.925	10.325	0.4					
		25 10D	4.95	7.45	2.5					
		25 15D	5.425	9.725	4.3					
	HOGSMILL	50 5D	3.525	7.275	3.75					
	US THAMES	25 10D	6.65	23.95	17.3					
		25 15D	10.525	25.925	15.4					

Fig 1A: Graph of results from Table 1A - BOD test with + without ATU for samples taken on 4.9.90

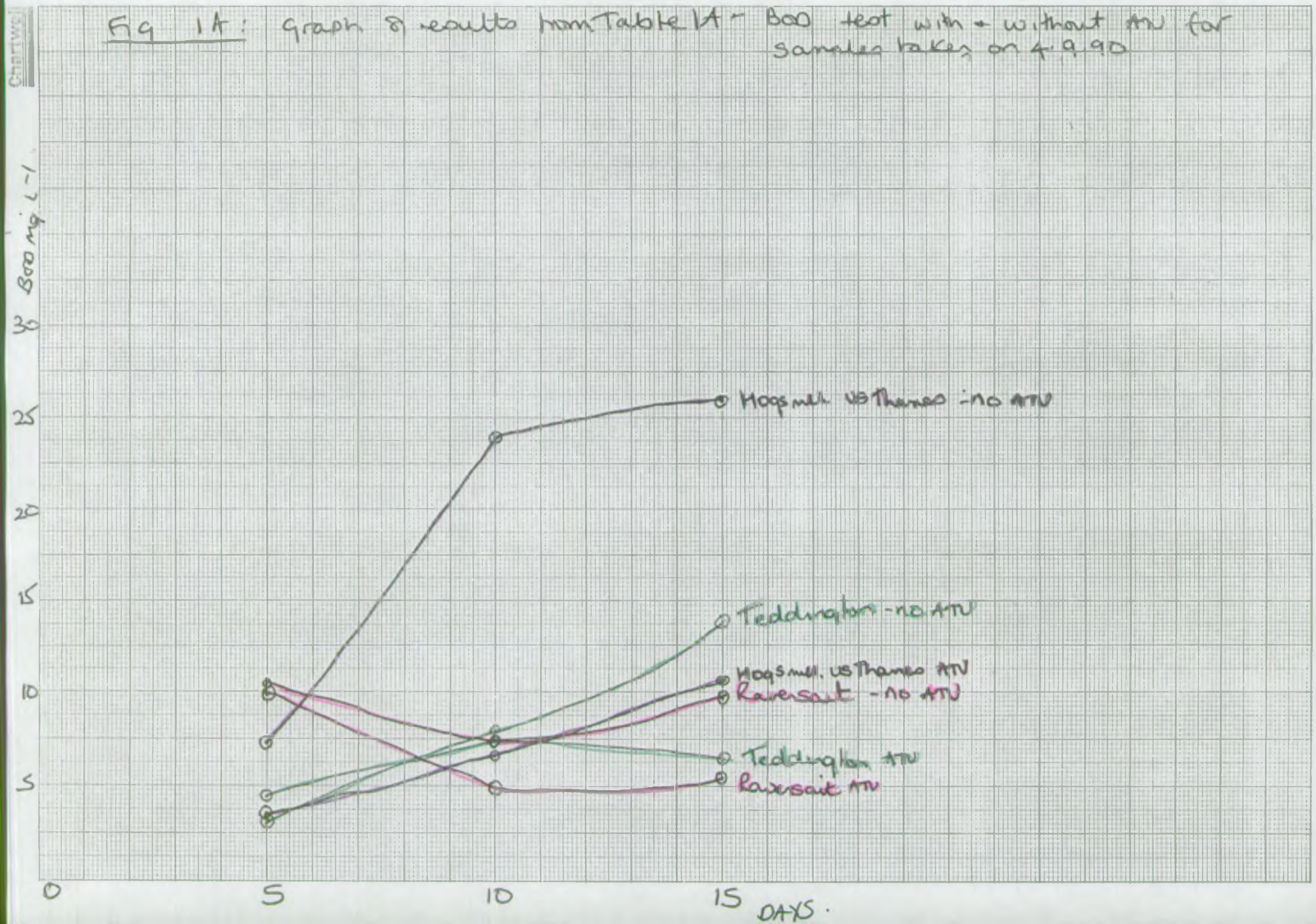


TABLE 2: B.O.D. WITH AND WITHOUT ATU FOR STW EFFLUENTS SAMPLES

STW SAMPLE	DATE	DILUTION X DAY (D)	BOD(ATU)	BOD	BOD - BOD(ATU)	ATU ml	NH3 DAY 0	NH3 DAY 2	NH3 DAY 4	NH3 DAY 5	NH3 DAY 10
BECTON	25.7.90	54 5D	3.95								
		27 10D	6.355								
		27 20D	8.651								
		9 30D	4.459								
CROSSNESS	25.7.90	54 5D	6.24								
		27 10D	18.099								
		27 20D	9.531								
		9 30D	2.351								
MOGDEN	27.7.90	54 5D	3.819								
		27 10D	7.217								
		27 20D	10.909								
		9 30D	17.57								
KEW	27.7.90	54 5D	3.819								
		27 10D	3.738								
		27 20D	5.409								
		9 30D	26.46								
MOGDEN	17.8.90	54 5D	2.895	4.362	1.467	0	0.16		0.1	0.13	0.03
		27 10D	5.193	8.401	3.208	0.5	0.16		0.23	0.24	0.24
		27 20D	8.067	13.385	5.318	1	0.16		0.33	0.3	0.36
		9 30D	12.901								
HOGSMILL	17.8.90	54 5D	2.575	7.615	5.04	0	1.3		0.36	0.1	0.6
		27 10D	2.259	11.609	9.35	0.5	1.3		1.32	1	1.1
		27 20D	6.876	15.951	9.075	1	1.3		1.44	1.2	1
		9 30D	9.876								
LONGREACH	20.8.90	27 5D	2.351								
		9 10D	10.05								
		9 20D	11.075								
		5 30D	16.85								
NORTHFLEET	20.8.90	27 5D	9.959								
		9 10D	24.35								
		9 20D	28.675								
		5 30D	36.099								
RIVERSIDE	20.8.90	27 5D	5.651								
		9 10D	35.075								
		9 20D	20.975								
		5 30D	20.058								
TILBURY	20.8.90	9 5D	16.099								
		5 10D	46.899								
		5 20D	55.349								
		1.8 30D	70.477								
CROSSNESS	20.8.90	54 5D	4.962	12.569	7.607	0	1.66	0.4		0.02	
		27 10D	8.126	20.961	12.835	0.5	1.59	1.9		1.2	
		27 20D	11.443	22.838	11.395						
		9 30D	15.475								
BECTON	20.8.90	54 5D	0.334	2.946	2.612	0	0.25	0.23		0.31	
		27 10D	3.542	9.135	5.593	0.5	0.29	0.24		0.2	
		27 20D	5.484	12.085	6.601						
		9 30D	5.025								
GRAVESEND	20.8.90	9 5D	<83.75								
		5 10D	<154.79								
		5 20D	<151.59								
		1.8 30D	258.852								

Fig 2: GRAPH OF RESULTS from TABLE 2 - BOD TEST WITH ATU for Effluent Samples

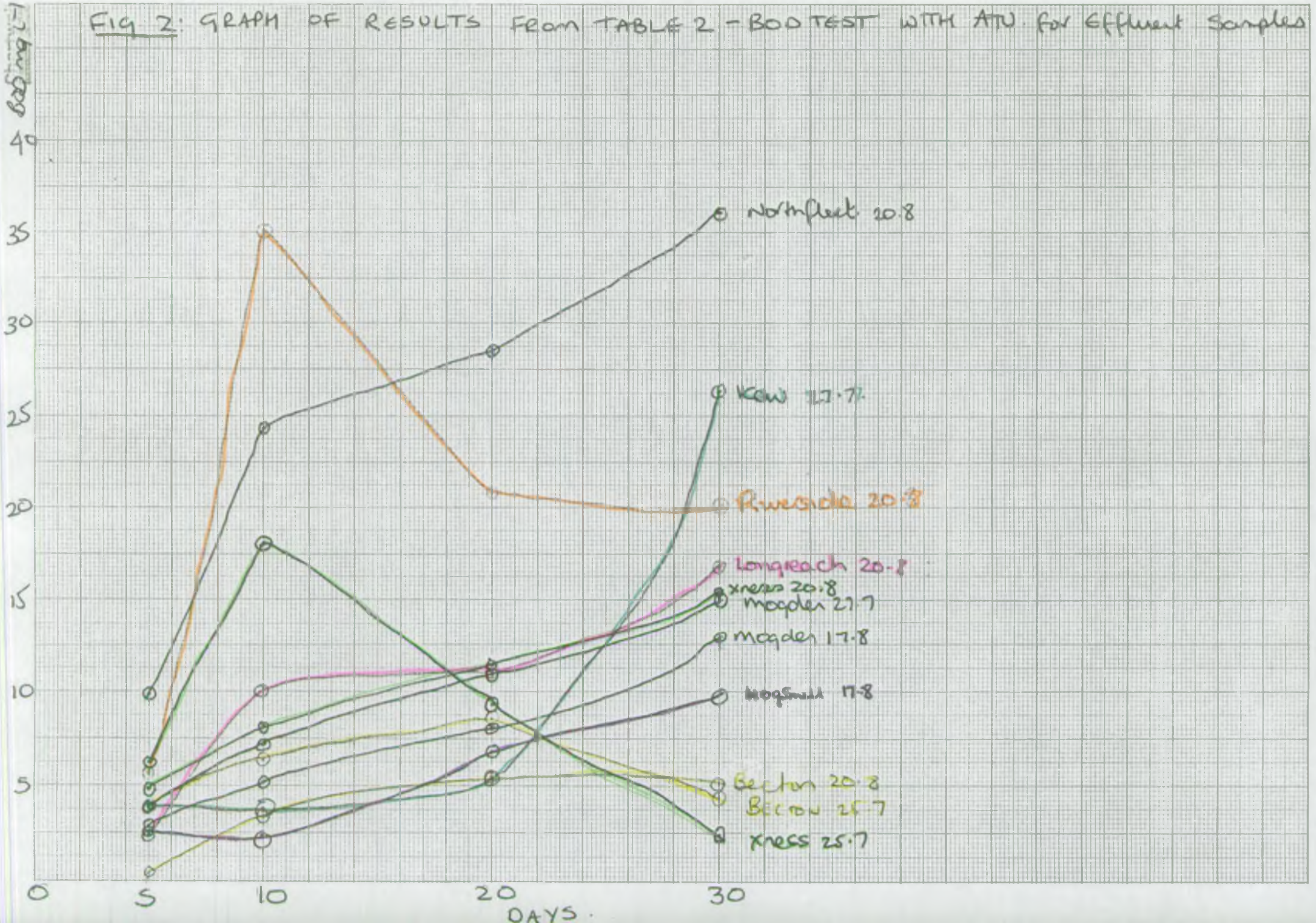


TABLE 3: B.O.D.(ATU) OF FILTERED AND UNFILTERED TIDEWAY RIVER RUN SAMPLES

BOD FILTERED AND UNFILTERED
23.8.90

ZONE	BOD(ATU) UNFILT	BOD(ATU) FILT	DIFFERENCE (U-F)
2	2.76	0.77	1.99
3	2.47	0.92	1.55
4	1.94	0.14	1.8
5	0.88	0.49	0.39
6	0.86	0.36	0.5
7	0.66	1.14	-0.49
8	0.95	0.64	0.31
9	1.65	0.45	1.2
10	1.45	0.53	0.92
11	1.31	0.58	0.73
12	1.15	0.18	0.97
13	0.69	0.36	0.33
15	0.65	0.91	-0.26
16	1	0	1
17	5	6.2	-1.2
18	3.65	3.9	-0.25
19	4.15	3.95	0.2
20	2.225	2.975	-0.75
21	4	4.125	-0.125
22	1.1	1.7	-0.6
24	2.375	2.7	-0.325
25	4.125	5.15	-1.025

BOD FILTERED AND UNFILTERED
19.9.90

ZONE	BOD(ATU) UNFILT	BOD(ATU) FILT	DIFFERENCE (U-F)	NH3 UNFILT	NH3 FILT
2	6.25	0.525	5.725	0.29	0.24
3	4.4	2.55	1.85	0.21	0.15
4	2.005	0.05	1.955	0.12	0.09
5	1.88	0	1.88	0.06	0.03
6	1.35	0	1.35	0.01	0.02
7	1.675	0.33	1.345	0.01	0.01
8	1.63	0	1.63		
9	1.575	0	1.575		
10	1.075	0	1.075		
11	1.38	0	1.38		
12	1.625	0.38	1.245		
13	1.05	0.68	0.37		
14	2.075	0.175	1.9		
15	1.33	1.355	-0.025		
16	0.675	0.73	-0.055		
18	0.75	0.88	-0.13		
20	0.255	0.2	0.055		
21	0.975	0.275	0.7		
22	0.98	0.8	0.18		
24	1.255	1.18	0.075		

TABLE 4A & 4B: B.O.D. WITH AND WITHOUT ATU TO INVESTIGATE NITRIFICATION IN THE UPPER TIDEWAY ZONES 3-10

TABLE 4A: BOD USING DILUTION WATER

NITRIFICATION IN UPPER TIDEWAY
WITH DILUTION WATER

30.8.90

ZONE	DILUTION % DAY (D)	BOD(ATU)	BOD	BOD - BOD(ATU)	NH3 0 DAY	NH3 5 DAY
3	100 5D	2.25	3.675	1.425	0.23	0
3	54 10D	4.185	7.003	2.818		
3	54 15D	4.909	7.567	2.658		
4	100 5D	2.8	4.1	1.3	0.13	0
4	54 10D	5.2158	9.34	4.1242		
4	54 15D	6.422	9.515	3.093		
5	100 5D	2	3.075	1.075	0.16	0
5	54 10D	3.474	7.095	3.621		
5	54 15D	5.07	7.774	2.704		
6	100 5D	1.6	2.05	0.45	0.07	0
6	54 10D	2.237	4.941	2.704		
6	54 15D	3.099	3.97	0.871		
7	100 5D	0.95	1.7	0.75	0.01	0
7	54 10D	1.713	4.254	2.541		
7	54 15D	1.129	4.887	3.758		
8	100 5D	0.25	0.5	0.25	0	0
8	54 10D	1.137	2.512	1.375		
8	54 15D	0.9458	2.962	2.0162		
9	100 5D	0.425	1.3	0.875	0	0
9	54 10D	0.679	2.741	2.062		
9	54 15D	1.312	3.191	1.879		
10	100 5D	0.4	0.725	0.325	0	0
10	54 10D	0.45	1.779	1.329		
10	54 15D	1.496	3.466	1.97		

TABLE 4B: BOD WIHOUT DILUTION WATER

NITRIFICATION IN THE UPPER TIDEWAY
LONG TERM BOD WITHOUT DILN WATER

25.10.90 (SAMPLED ON 24.10.90)

ZONE	DAY (D)	BOD(ATU)	BOD	BOD - BOD(ATU)
3	5D	2.675	5.5	2.825
3	10D	3.925	7.2	3.275
3	15D	5.375	8.25	2.875
3	20D	7.475	10.8	3.325
4	5D	2.35	4.225	1.875
4	10D	3.725	5.815	2.09
4	15D	4.625	7.465	2.84
4	20D	7.775	11.415	3.64
5	5D	1.95	3.4	1.45
5	10D	3.25	5	1.75
5	15D	3.35	5.9	2.55
5	20D	6.15	9.05	2.9
6	5D	2.15	3.625	1.475
6	10D	3.45	5.625	2.175
6	15D	4.35	6.575	2.225
6	20D	8	10.975	2.975
7	5D	2.025	2.875	0.85
7	10D	3.7	5.3	1.6
7	15D	5.8	7.55	1.75
7	20D	8.05	11.45	3.4
8	5D	2.175	2.725	0.55
8	10D	3.375	4.165	0.79
8	15D	4.525	6.165	1.64
8	20D	6.375	9.065	2.69
9	5D	1.9	2.55	0.65
9	10D	3.5	3.95	0.45
9	15D	4.7	6.1	1.4
9	20D	7.3	9	1.7
10	5D	0.95	1.5	0.55
10	10D	1.325	1.975	0.65
10	15D	2.375	3.325	0.95
10	20D	4.475	5.775	1.3

Fig 4A i :- Results from table 4A - BOD TEST with ATU + Dilution Water for Upper Tideway Samples - 30.8.90

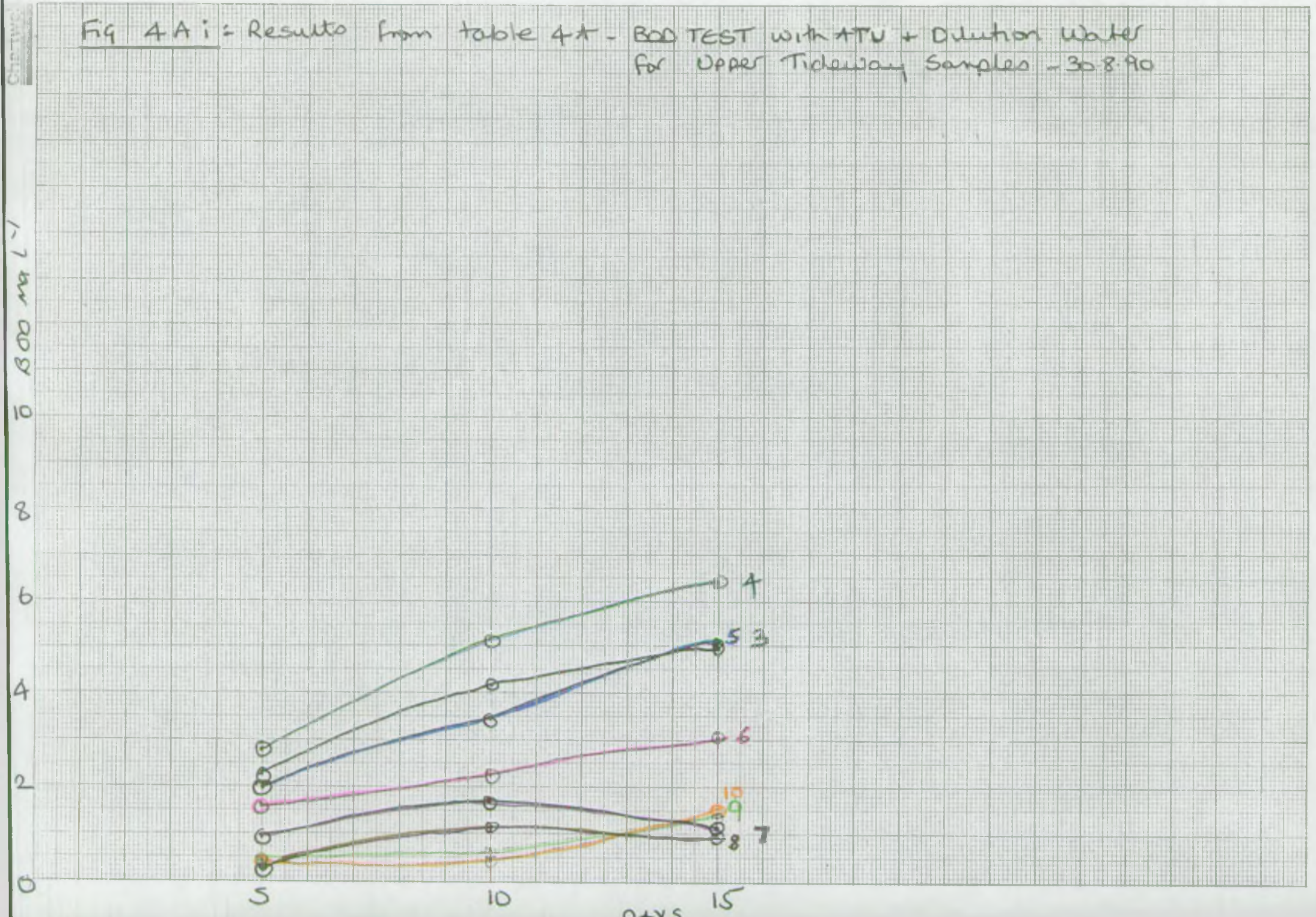


Fig 4A ii - Results from Table 4A - BOD test without ATU + with dilution for Upper Tideway Samples 30 & 90

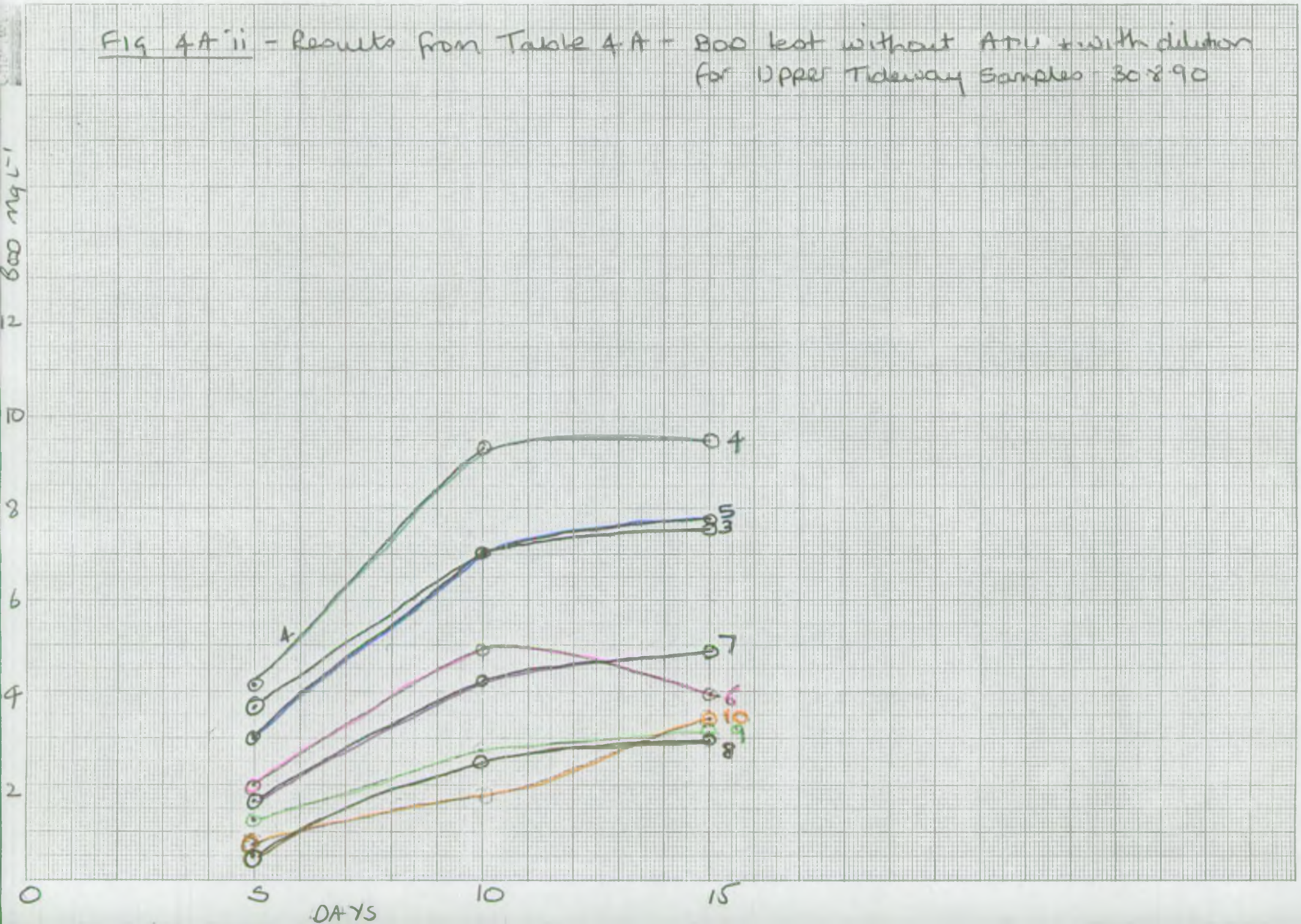


Fig 4B i + Results from Table 4B + BOD test with ATU, without Dilution water for Upper Tideway Samples -25.10.90

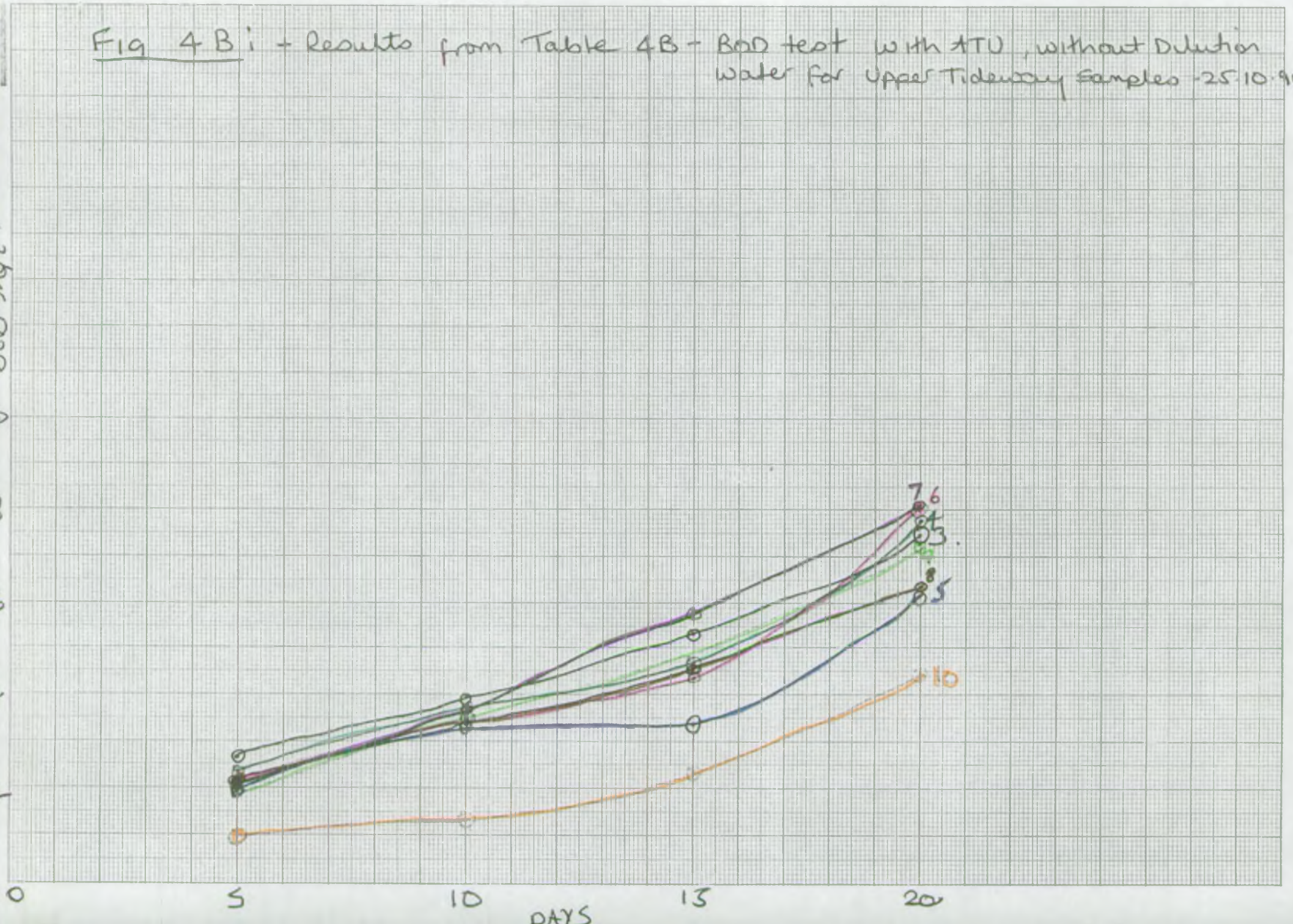


Fig 4 B'ii – Results from Table 4 B – BOD test without ATU + dilution water for Upper Tideway samples - 25.10.90

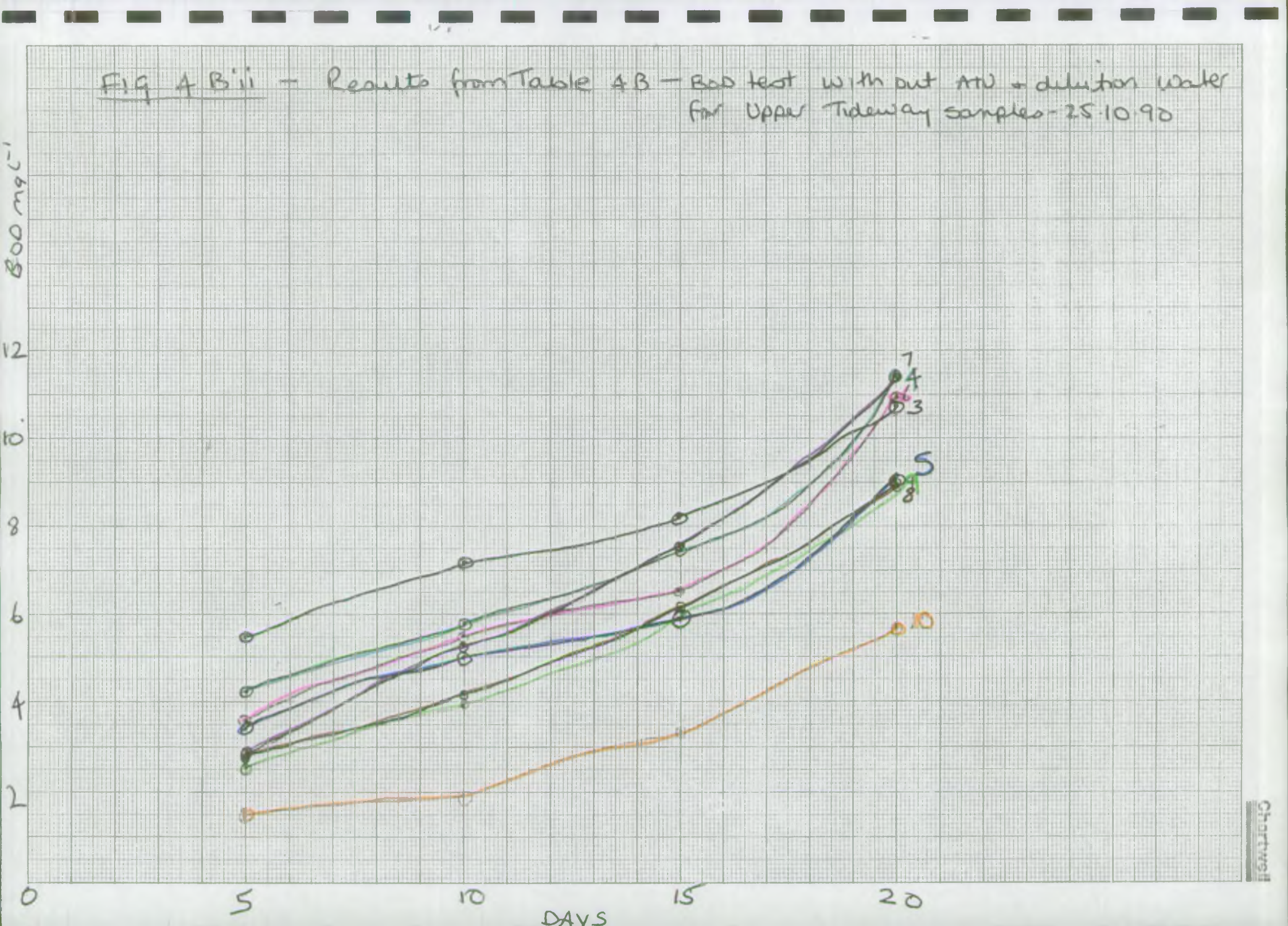


TABLE 5: RESULTS OF B.O.D. TESTS WITH & WITHOUT ATU IN WATER SAMPLES TAKEN BETWEEN KINGSTON & TEDDINGTON AFTER HIGH AMMONIA IN HOGSMILL FINAL EFFLUENT ENTERED THE THAMES

SATURDAY 8.9.90

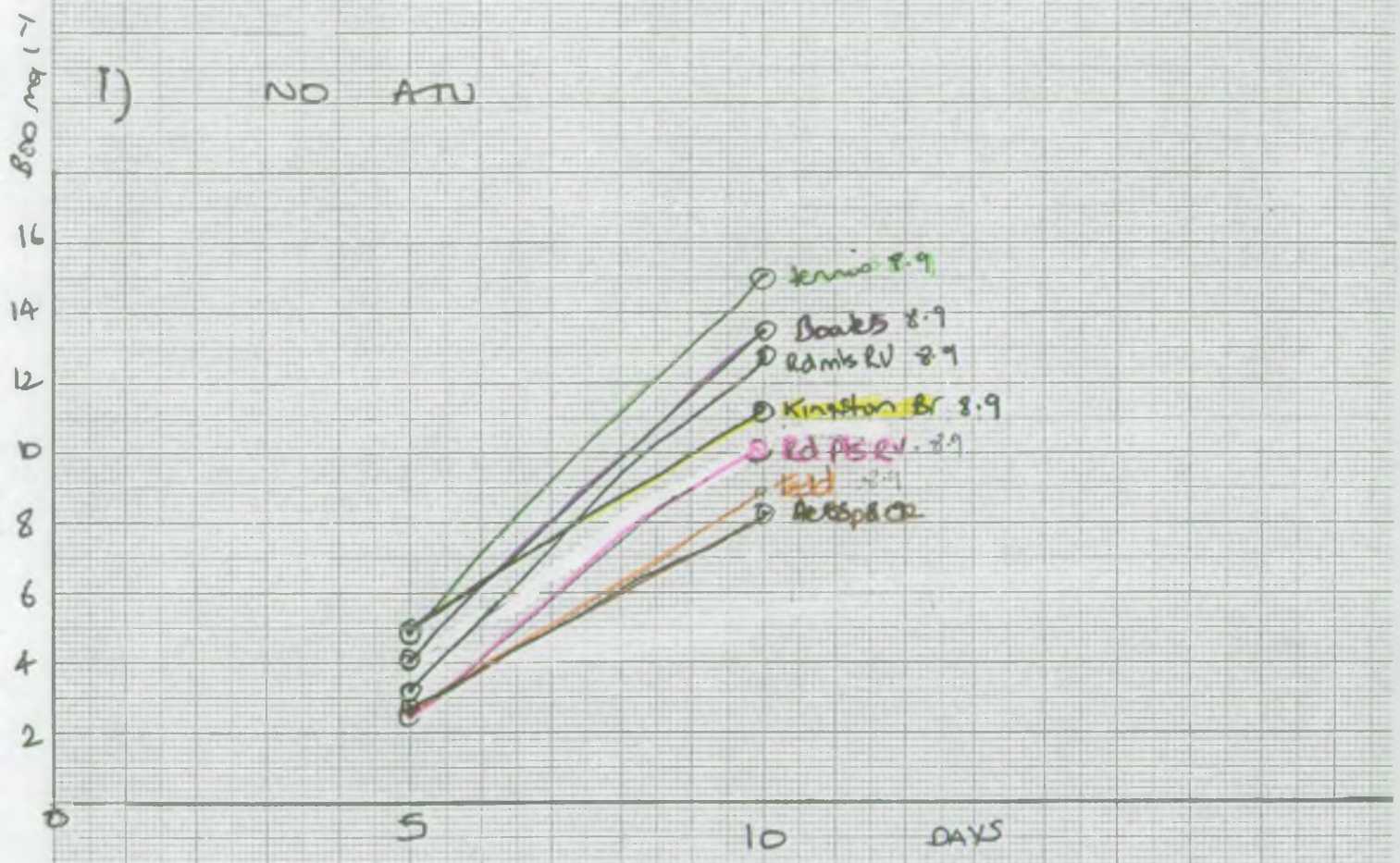
SAMPLE	DILN % DAY (D)	BOD(ATU)	BOD	BOD - BOD(ATU)	NH3
KINGSTON RAIL BR	50 5D	2.075	4.925	2.85	1.92
	25 10D	4.575	11.275	6.7	
KINGSTON TENNIS CT	50 5D	1.925	4.975	3.05	3.08
	25 10D	6.025	15.125	9.1	
THE BOATERS PH	50 5D	1.95	4.15	2.2	2.2
	25 10D	3.675	13.575	9.9	
LWR HAM RD MEETS RIVER	50 5D	2.525	3.425	0.9	1.3
	25 10D	4.025	12.725	8.7	
LWR HAM RD PARTS FROM RIVER	50 5D	1.075	2.575	1.5	1.42
	25 10D	4.275	10.075	5.8	
BROOM WATER	50 5D			0	1
	25 10D			0	
BRIT. AEROSPACE	50 5D	1.375	2.825	1.45	1.18
	25 10D	3.175	8.375	5.2	
TEDDINGTON	50 5D	0.525	2.525	2	0.8
	25 10D	4.075	8.875	4.8	

SUNDAY 9.9.90

SAMPLE	DILN % DAY (D)	BOD(ATU)	BOD	BOD - BOD(ATU)	NH3
KINGSTON RAIL BR	50 5D	2.725	4.275	1.55	0.74
	25 10D	5.075	5.275	0.2	
KINGSTON TENNIS CT	50 5D	3.205	4.155	0.95	0.47
	25 10D	3.495	10.295	6.8	
THE BOATERS PH	50 5D	2.485	3.385	0.9	0.29
	25 10D	5.095	10.895	5.8	
LWR HAM RD MEETS RIVER	50 5D	4.025	5.975	1.95	0.66
	25 10D	7.535	12.335	4.8	
LWR HAM RD PARTS FROM RIVER	50 5D	3.765	5.265	1.5	1.41
	25 10D	5.005	12.555	7.55	
BROOM WATER	50 5D	2.605	4.155	1.55	2.2
	25 10D	5.395	11.895	6.5	
BRIT. AEROSPACE	50 5D	2.855	3.255	0.4	2.1
	25 10D	5.395	10.395	5	
TEDDINGTON	50 5D	1.225	3.825	2.6	1.5
	25 10D	4.775	13.975	9.2	

Fig 5A: RESULTS FROM TABLE 5 OF HIGH AMMONIAS IN R. THAMES FOR SATURDAY 8.9.90

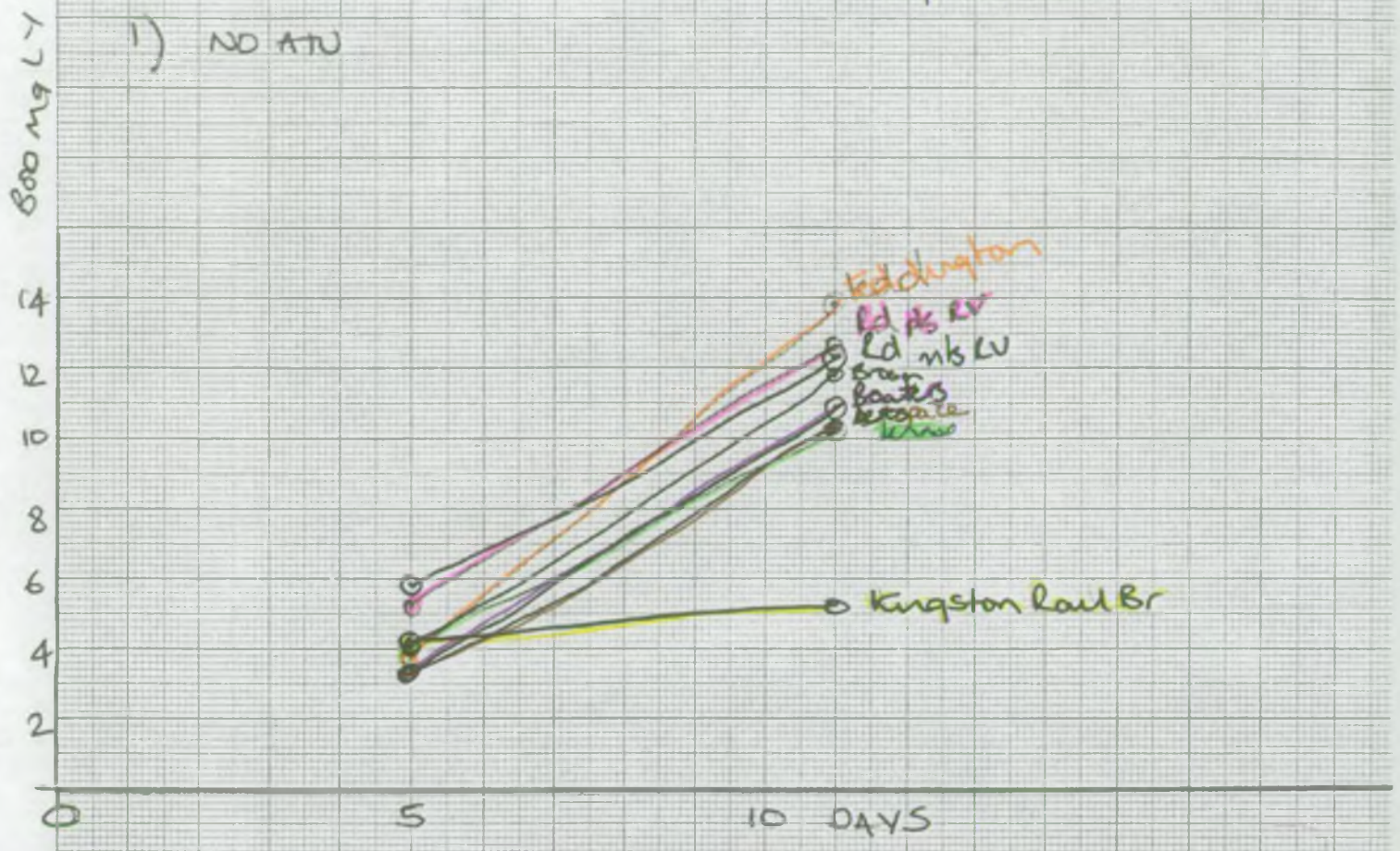
1) NO ATU



2) ATU

FIG 5B: Results from Table 5 of High Ammonias in R. Thames for Sunday 99.90

1) NO ATU



2) ATU

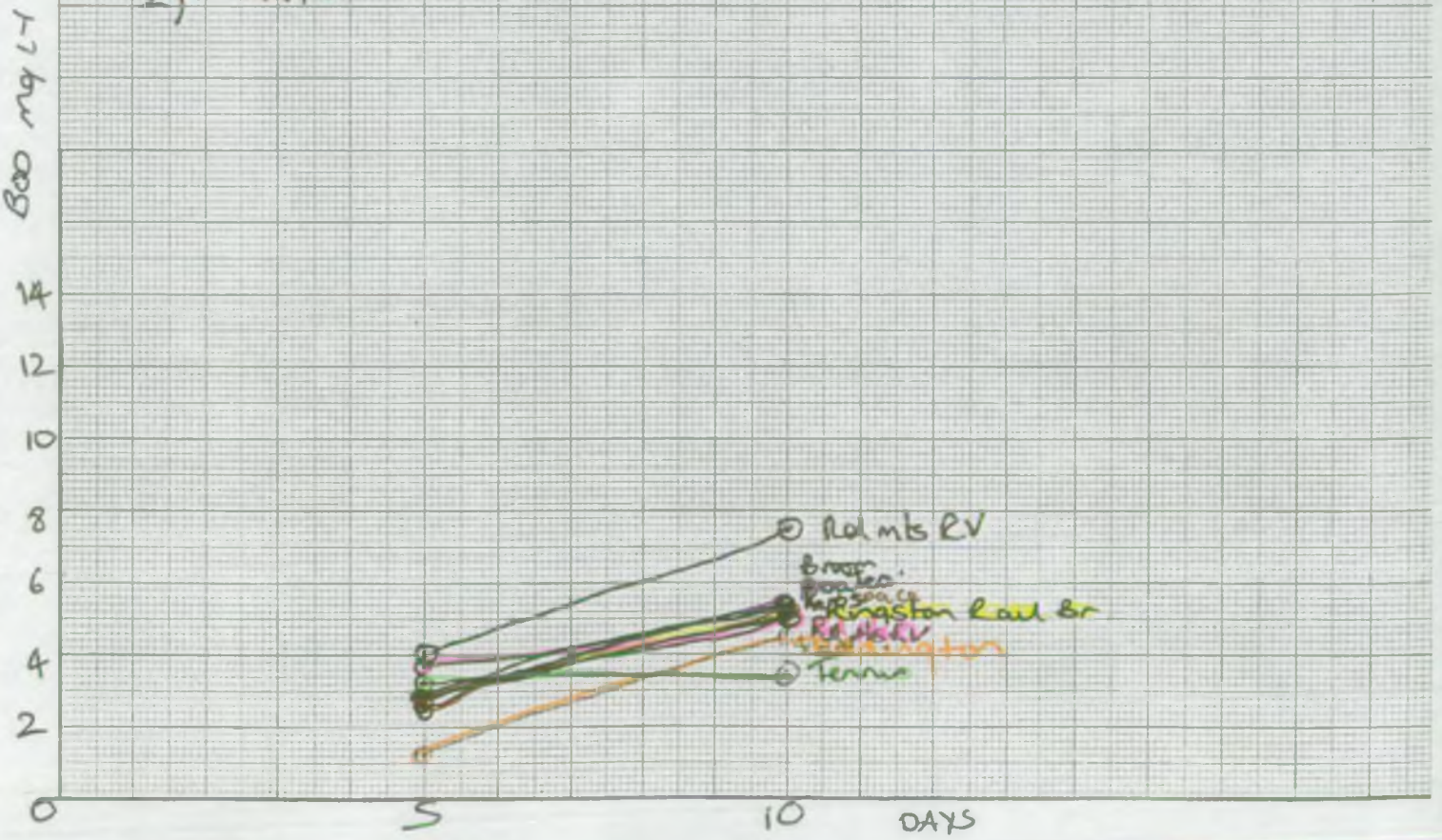


TABLE 6: RESULTS OF B.O.D. TESTS WITH AND WITHOUT ATU IN WATER SAMPLES TAKEN BETWEEN KINGSTON & TEDDINGTON AFTER HIGH AMMONIA IN HOGSMILL STW EFFLUENT ENTERED THE THAMES

DATE: 25.9.90

SAMPLE	DILN	DAY	% BOD(ATU) (D)	BOD	BOD - BOD(ATU)	NH3 DAY 0	NH3 DAY 5	ORG N
KINGSTON	54	5D	2.025	2.116	0.091	1.18	0.61	
RAIL BRIDGE	27	10D	4.4	9.534	5.134			
site 1	18	20D	5.449	19.337	13.888			
	9	30D	12.801	4.001	-8.8			
	5	40D	14.965	40.631	25.666			
KINGSTON	54	5D	1.383	3.033	1.65	2.35	0.96	
TENNIS CT	27	10D	0	9.534	9.534			
site 2	18	20D	3.799	22.499	18.7			
	9	30D	8.401	32.601	24.2			
	5	40D	8.549	58.965	50.416			
BOATERS PH	54	5D	1.658	1.749	0.091	2.05	1.4	1.15
site 3	27	10D	2.934	13.568	10.634			
	18	20D	4.792	20.162	15.37			
	9	30D	6.751	34.801	28.05			
	5	40D	25.965	58.964	32.999			
LOWER HAM RD	54	5D	4.399	4.811	0.412	2.55		1.2
MEETS RIVER	27	10D	2.05	14.335	12.285			
site 4	18	29D	8.549	25.875	17.326			
	9	30D	25.85	52.8	26.95			
	5	40D	48.016	65.432	17.416			
LOWER HAM RD	54	5D	2.483	5.232	2.749	1.95	1.6	1.05
BOAT HOUSE	27	10D	0.733	14.668	13.935			
site 5	18	20D	7.925	24.837	16.912			
	9	30D	5.101	9.501	4.4			
	5	40D	19.548	55.298	35.75			
LOWER HAM RD	54	5D	2.383	4.583	2.2	1.85		
LEAVES RIVER	27	10D	1.684	13.051	11.367			
site 6	18	29D	9.099	23.949	14.85			
	9	30D	20.9	40.15	19.25			
	5	40D	15.93	49.849	33.919			

SAMPLE	DILN	DAY	% BOD(ATU) (D)	BOD	BOD - BOD(ATU)	NH3 DAY 0	NH3 DAY 5	ORG N
TOW PATH	54	5D	1.933	4.041	2.108	1.7	1.55	
site 7	27	10D	2.567	13.201	10.634			
	18	20D	4.349	20.987	16.638			
	9	30D	11.151	31.501	20.35			
	5	40D	26.882	45.215	18.333			
BRITISH	54	5D	2.199	1.833	-0.366	1.15		
AEROSPACE	27	10D	0.033	13.235	13.202			
site 8	18	29D	9.375	22.025	12.65			
	9	30D	20.9	46.2	25.3			
	5	40D	30.599	56.266	25.667			
BROOM WATER	54	5D	1.383	2.428	1.045	1.25		
site 9	27	10D	0.65	8.651	8.001			
	18	29D	7.999	19.275	11.276			
	9	30D	4.95	30.25	25.3			
	5	40D	14.699	55.349	40.65			
TEDDINGTON	54	5D	1.383	2.208	0.825	1.25	0.71	1.25
site 10	27	10D	2.2	6.967	4.767			
	18	20D	2.425	15.625	13.2			
	9	30D	1.949	12.801	10.852			
	5	40D	12.215	40.631	28.416			
BLANK 25.9.90						0.47		
BLANK 26.9.90						0.39		

FIG 6A: Graphed results from table 6 of High Ammonias in R. Thames on 25.9.90. (BOD (NO ATU))

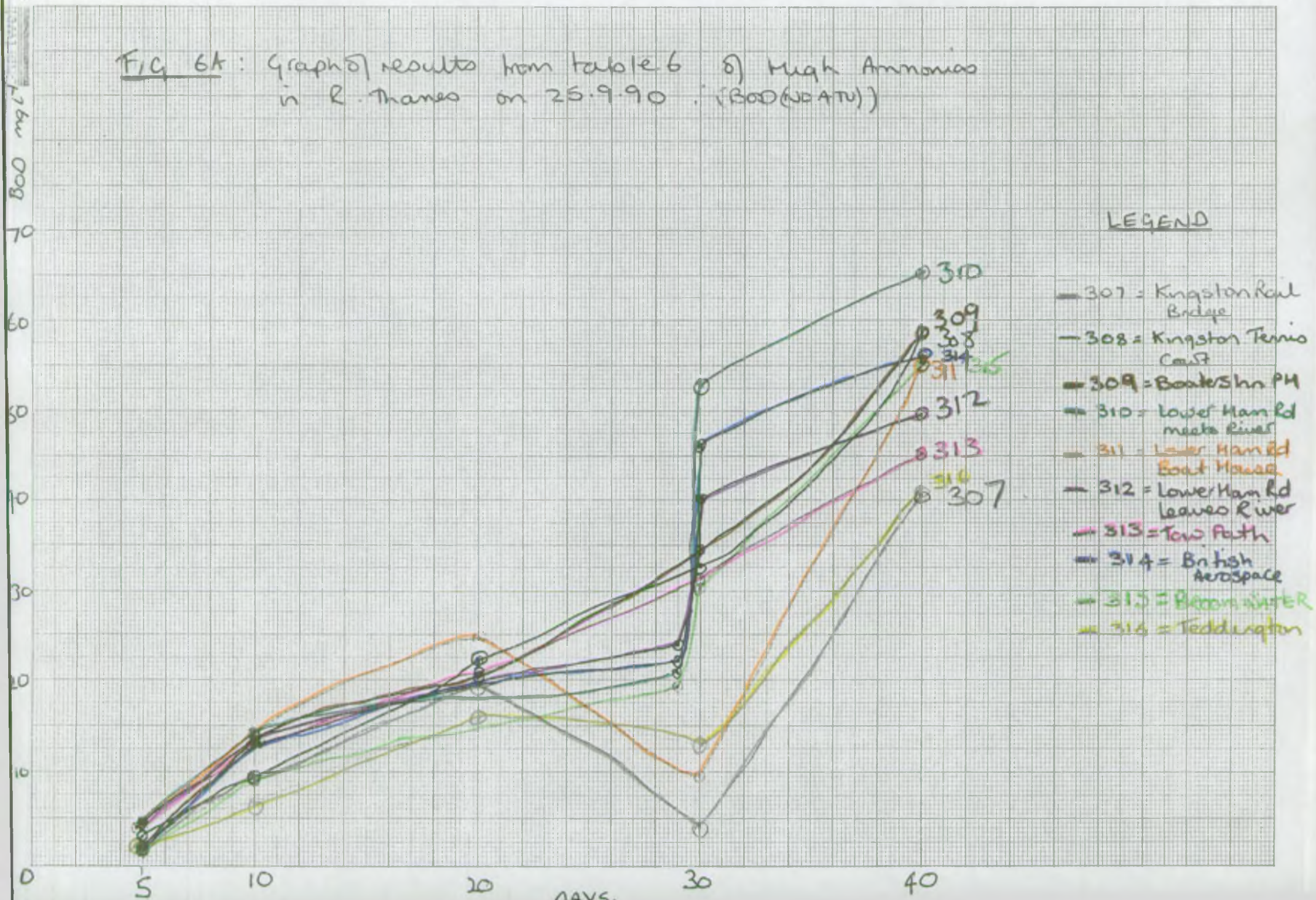


FIG 6B: Graph of results from Table 6 of High Ammonias in R Thames on 25.9.90 - BOD with ATU

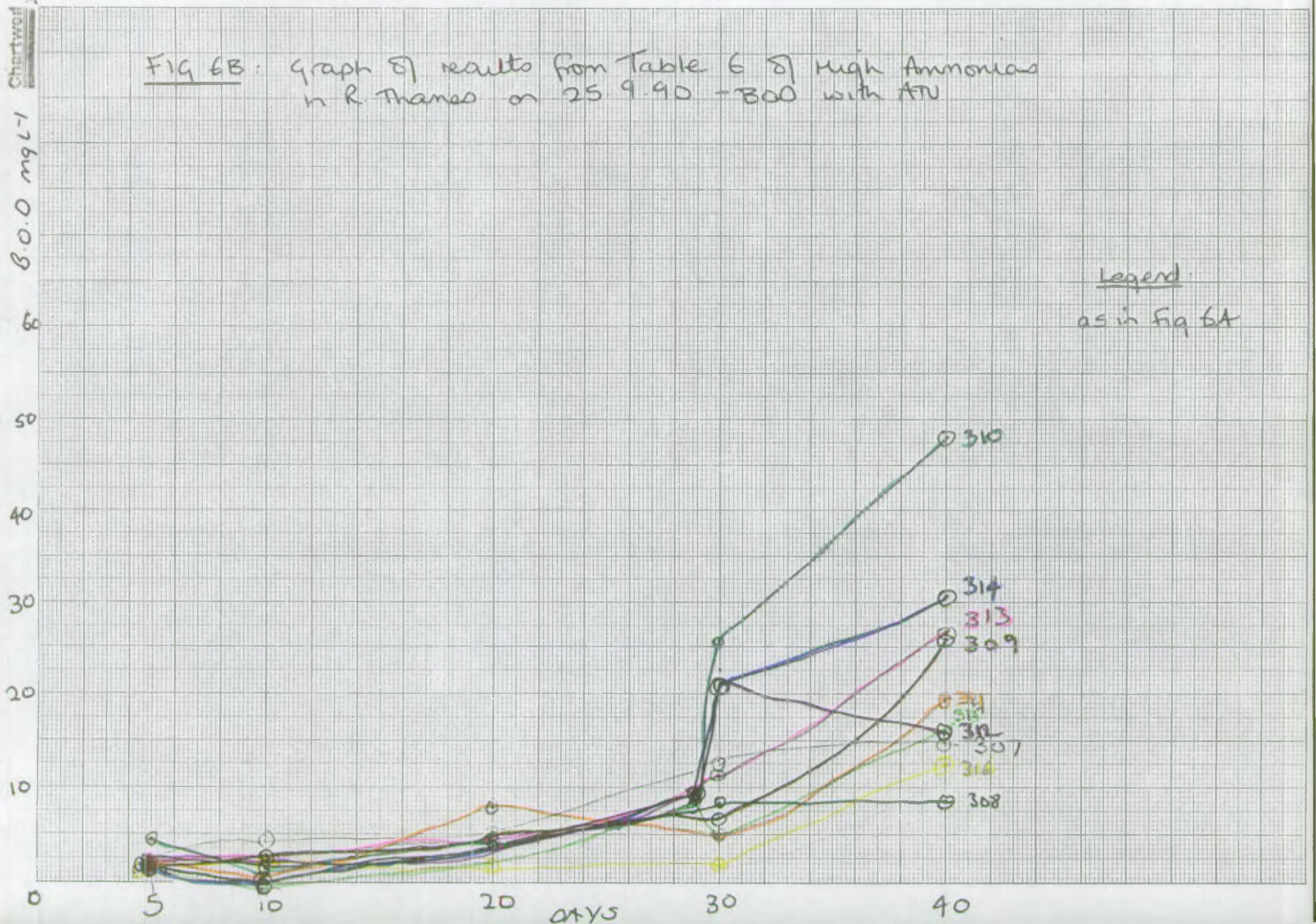


TABLE 7: LONG TERM B.O.D. WITH AND WITHOUT ATU FOR RIVER AND EFFLUENT SAMPLES

DATE	SAMPLE	DILN % DAY (D)	BOD(ATU)	BOD	BOD - BOD(ATU)	NH3 DAY 0
1.10.90	RAVENSAIT	50 5D	1.866	3.516	1.65	0.13
		27 10D	3.858	6.7	2.842	
		27 20D	5.817	12.602	6.785	
		18 30D	5.887	14.823	8.936	
		9 40D	12.251	18.851	6.6	
	WANDLE	100 5D	1.05	2.45	1.4	0.14
		27 10D	2.3	8.168	5.868	
		27 20D	5.634	13.335	7.701	
		18 30D	6.987	16.612	9.625	
		9 40D	9.499	18.299	8.8	
	KEW STW	50 5D	0	2.508	2.508	0.06
		27 10D	1.75	6.334	4.584	
		27 20D	6.184	10.951	4.767	
		18 30D	2.587	10.149	7.562	
		9 40D		22.699	22.699	
	MOGDEN	50 5D	0.767	4.982	4.215	0.09
		27 10D	3.4	7.342	3.942	
		27 20D	6	12.601	6.601	
		18 30D	11.523	18.949	7.426	
		9 40D	2.899	37.549	34.65	
	HOGSMILL	100 5D	1.45	5.45	4	0.13
	US STW	50 10D	7.799	8.119	0.32	
		27 20D	11.318	12.968	1.65	
		27 30D	9.326	16.568	7.242	
		18 40D	7.849	17.199	9.35	
	HOGSMILL	50 5D	0.858	3.791	2.933	0.07
	STW	27 10D	1.475	7.984	6.509	
		27 20D	7.834	12.417	4.583	
		18 30D	7.399	15.925	8.526	
		9 40D		25.999	25.999	
	HOGSMILL	50 5D	1.408	7.274	5.866	0.16
	US THAMES	27 10D	2.85	10.001	7.151	
		27 20D	2.883	13.885	11.002	
		18 30D	12.625	20.599	7.974	
		9 40D	1.799	28.199	26.4	
	BLANK					0.42

FIG. 7A: Graph of Results in Table 7 of Long term BOD tests without ATU for River and Effluent Samples.

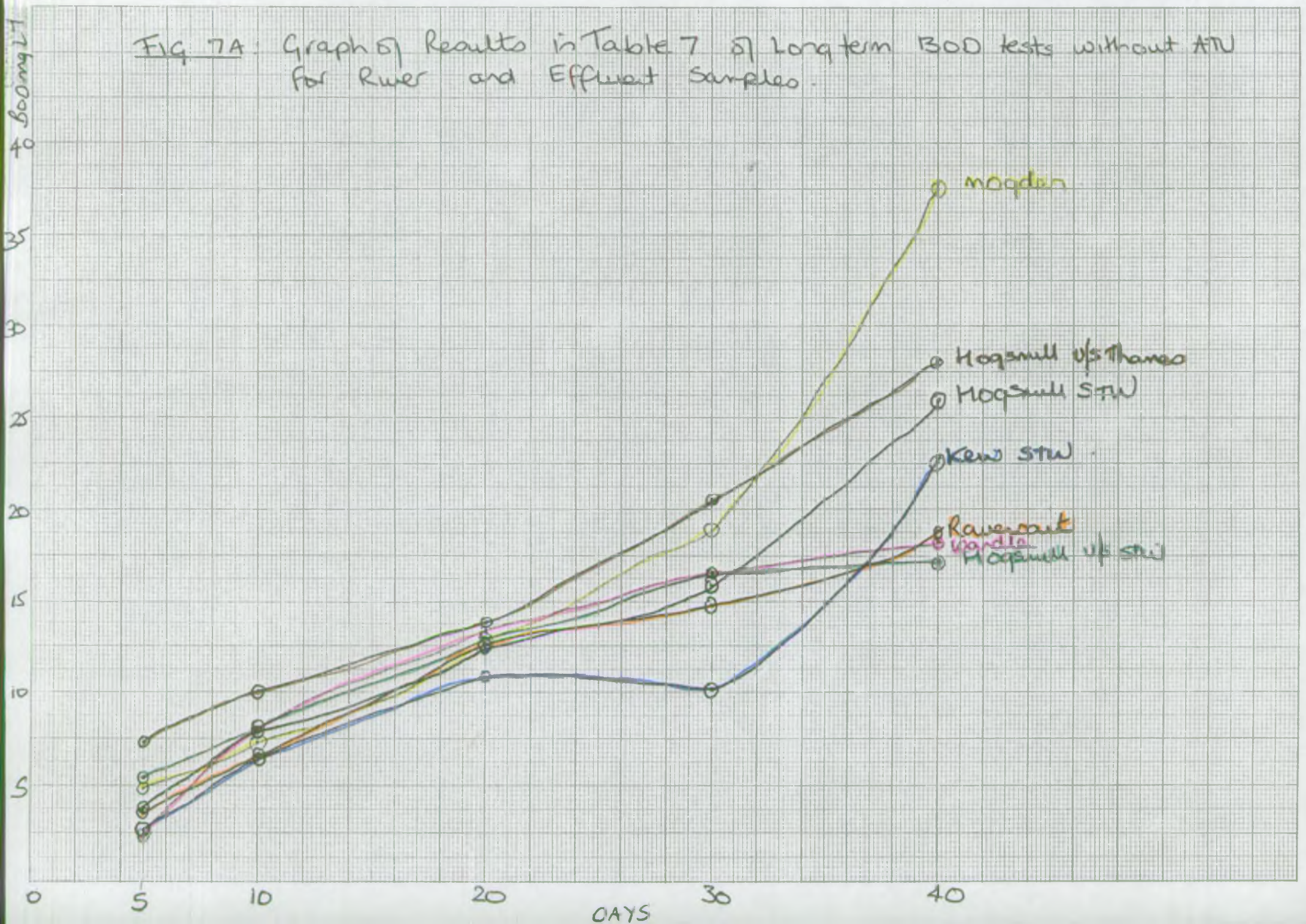


Table 7B : Graph of results from Table 7 of Long term BOD tests with ATU for River and Effluent samples

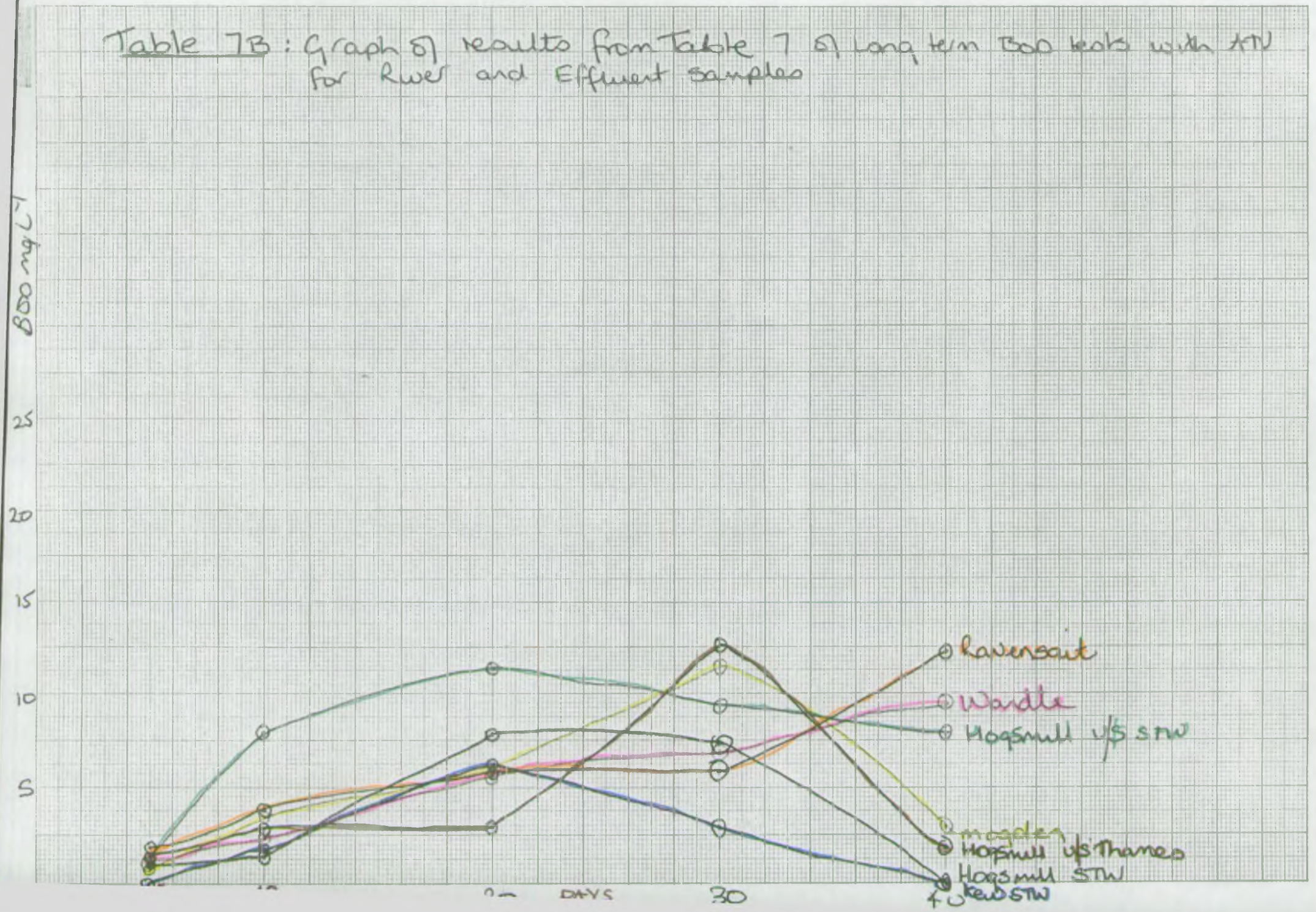


TABLE 8: B.O.D. OF RIVER AND EFFLUENT SAMPLES WITHOUT DILUTION WATER AND SOME COMPARABLE RESULTS AT 3 THE SITES WITH DILUTION WATER

BOD SAMPLES WITHOUT DILUTION WATER
7.12.90

SAMPLE	DAY	BOD(ATU)	BOD	BOD - BOD(ATU)
TEDDINGTON	5	2.75	6.65	3.9
	10	6.21	12.6	6.39
	20	8.71	15.7	6.99
	30	11.81	19.3	7.49
	40	16.06	23.75	7.69
KEW STW	5	4.33	6.18	1.85
	10	7.01	10.38	3.37
	20	10.51	15.66	5.15
	30	15.04	21.14	6.1
	40	16.84	24.04	7.2
WANDLE	5	3.05	4.55	1.5
	10	5.36	7.12	1.76
	20	8.14	12.12	3.98
	30	9.69	14.57	4.88
	40	11.69	17.12	5.43
HOGSMILL STW	5	7.1	10.5	3.4
	10	14	17.25	3.25
	20	19.95	25	5.05
	30	24.65	26.85	2.2
	40	28.3	31.15	2.85
HOGSMILL U/S	5	7.2	10.5	3.3
THAMES	10	14.7	18.37	3.67
	20	19.56	23.28	3.72
	30	21.89	26.26	4.37
	40	23.09	29.16	6.07
MOGDEN	5	7.7	10.3	2.6
	10	9.38	13.02	3.64
	20	12.23	17.52	5.29
	30	15.31	22.05	6.74
	40	18.31	25.45	7.14
RAVENSAIT	5	3.43	4.18	0.75
	10	13.1	14.33	1.23
	20	14.07	17.1	3.03
	30	16.15	19.78	3.63
	40	19.3	22.88	3.58
CROSSNESS STW	5	7.8	9.55	1.75
0.5ml ATU	10	14.92	17.65	2.73
	20	18.47	22.18	3.71
	30	21.62	26.43	4.81
	40	24.32	29.33	5.01
CROSSNESS STW	5	7.88	9.55	1.67
1ml ATU	10	15.03	17.65	2.62
	20	17.43	22.18	4.75
	30	19.88	26.43	6.55
	40	21.28	29.33	8.05

BOD SAMPLES WITH DILUTION WATER
7.12.90

SAMPLE	DAY	BOD(ATU)	BOD	BOD - BOD(ATU)
TEDDINGTON	5	1.254	14.454	13.2
	10	6.402	22.022	15.62
	20	11.905	39.906	28.001
	30	4.851	41.151	36.3
	40	12.4	33.3	20.9
KEW STW	5	11.374	15.224	3.85
	10	6.072	24.332	18.26
	20	17.906	26.794	8.888
	30	20.471	27.071	6.6
	40	14.27	32.97	18.7
RAVENSAIT	5	7.304	10.604	3.3
	10	4.422	4.422	0
	20	6.572	22.461	15.889
	30	4.851	27.951	23.1
	40	1.95	20.65	18.7

FIG 8Ai : Graph of results in Table 8 of BOD tests without dilution + with ATU for River and Effluent Samples

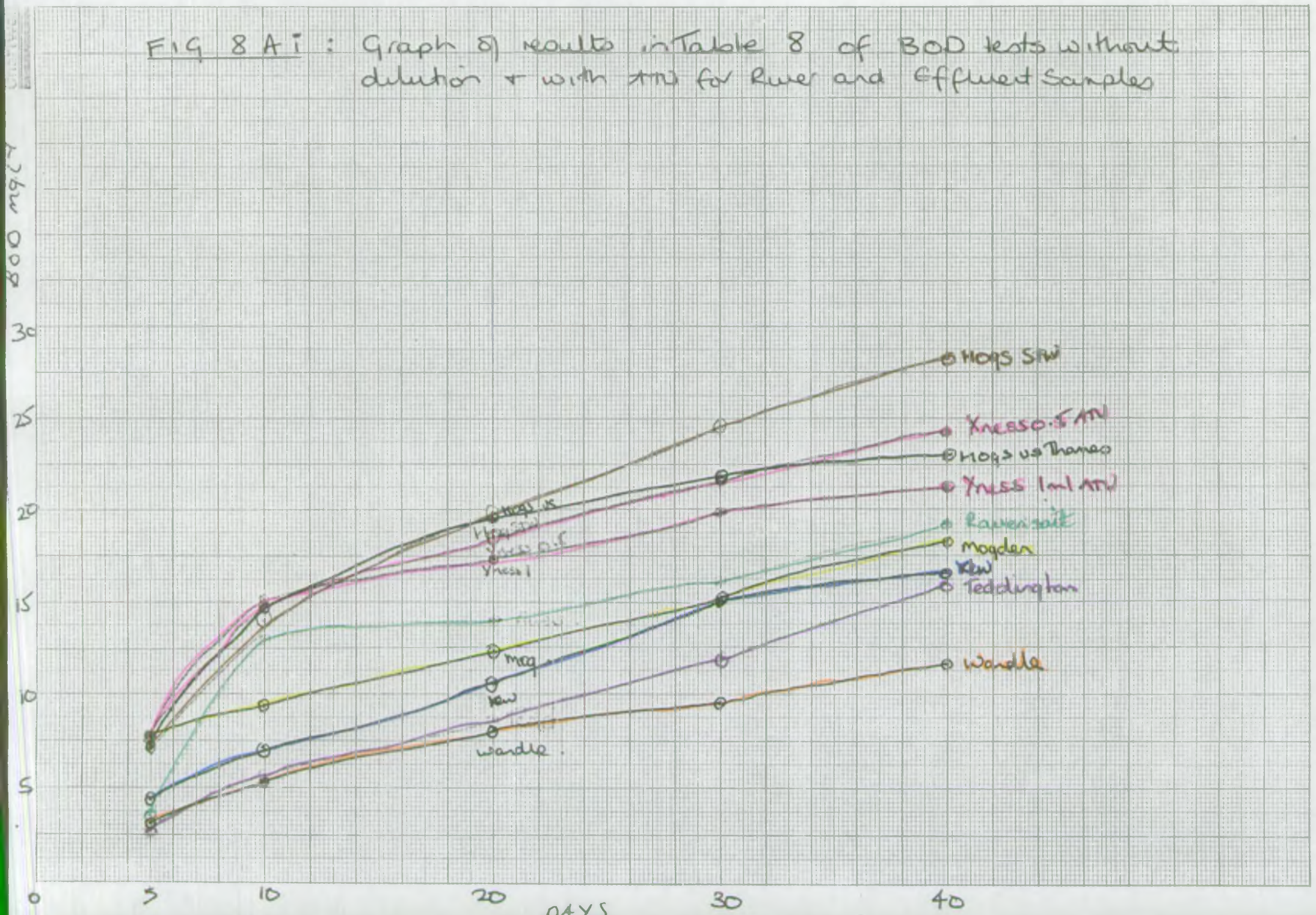


Fig 8 A ii : Graph of results in Table 8 of BOD tests without dilution water and without ATU for River + Effluent Samples

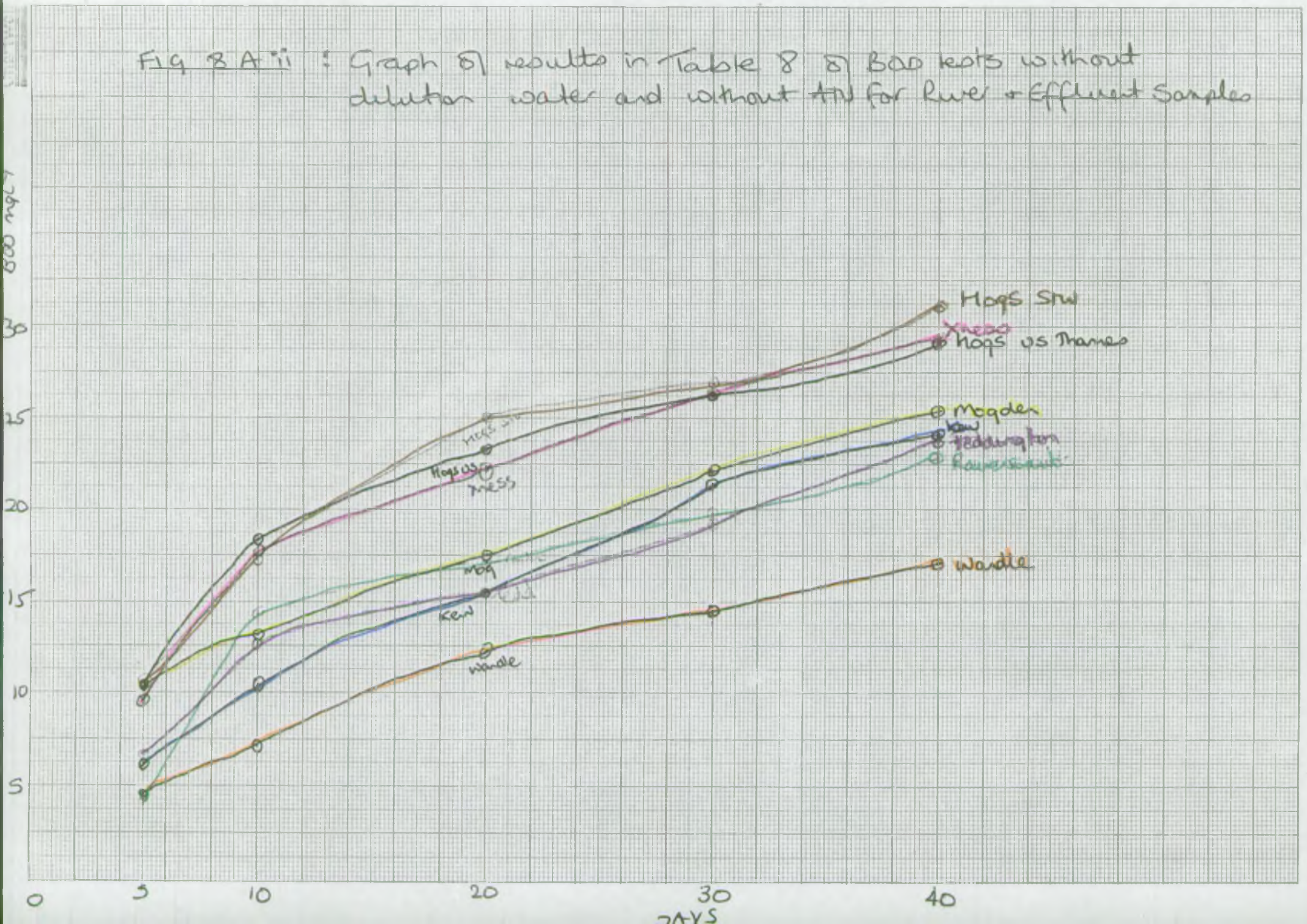
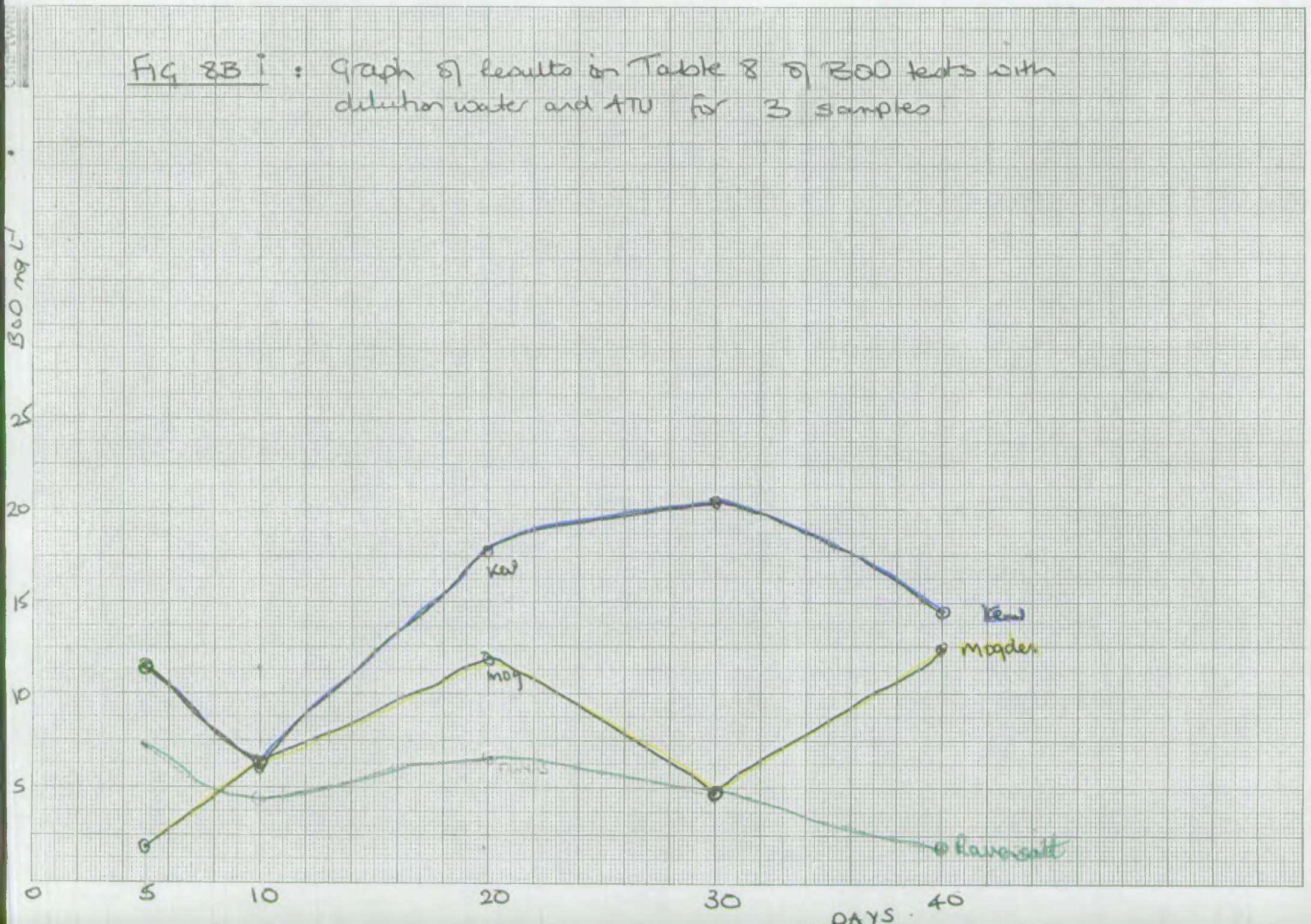


FIG 8B : Graph of results in Table 8 of BOD tests with dilution water and ATU for 3 samples



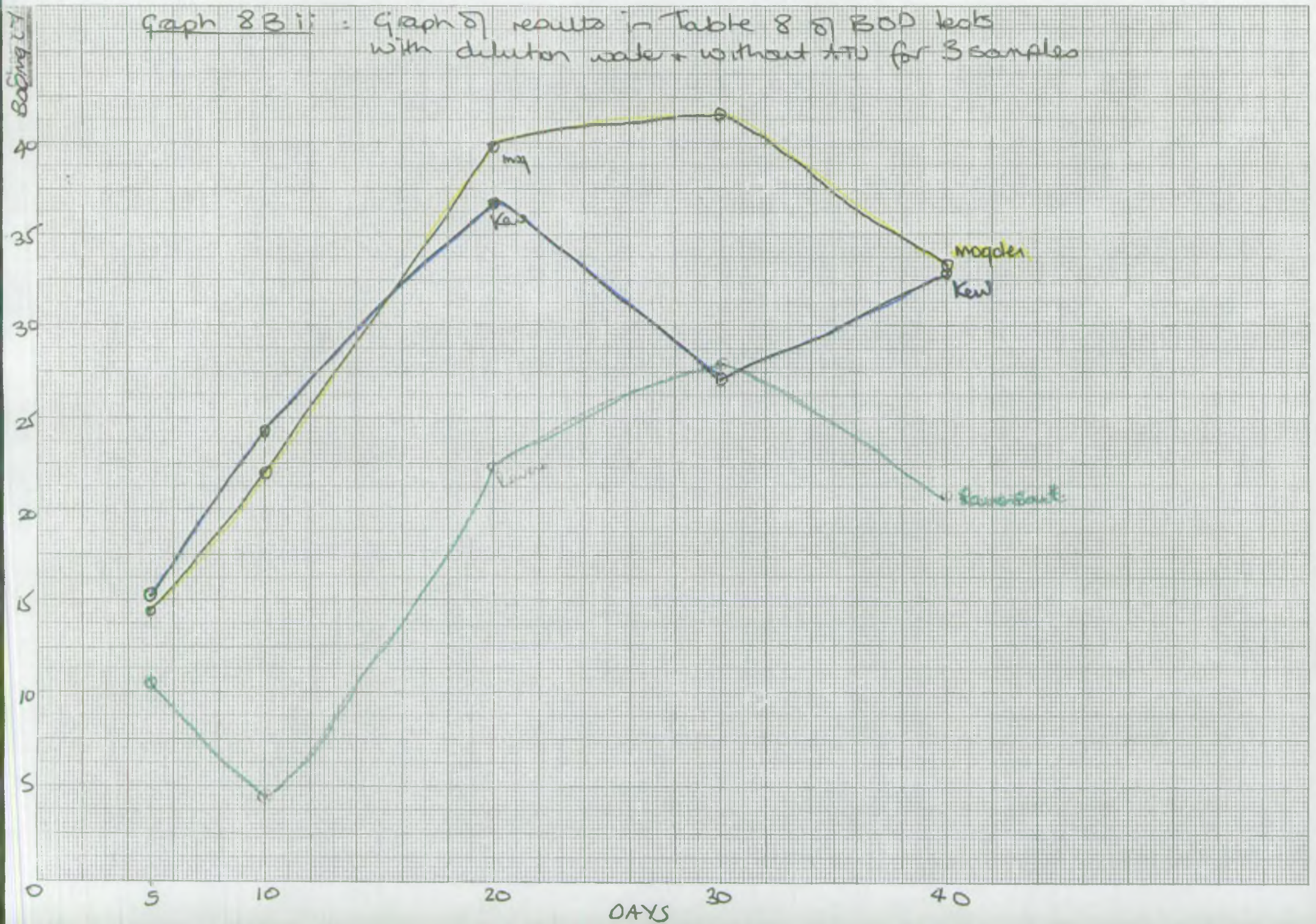

Graph 8Bi : Graph of results in Table 8 of BOD tests with dilution water + without ATU for 3 samples
BOD mg/L
40
35
30
25
20
15
10
5
0
5
10
20
30
40
DAYS
mog
Kew
mogden
Kew
Lower Sait

TABLE 9: B.O.D OF STW FINAL EFFLUENT WITHOUT DILUTION WATER

DATE	SAMPLE	DILN X DAY (D)	BOD(ATU)	BOD	BOD - BOD(ATU)	NH3 DAY 0	NH3 DAY 5	NH3 DAY 10	NH3 DAY 15
1.11.90	BEDDINGTON	5	1.6	2	0.4	0.06	0.1	0.04	0.07
	STW	10	3.9	4.95	1.05				
		15	5.1	6.65	1.55				
		20	7.05	9.15	2.1				
	HOGSMILL	5	3.35	7.85	4.5	2.95	0.55	0.05	0.02
	STW	10	7.35	14.1	6.75				
		15	9.45	17.5	8.05				
		20	12.9	19.65	6.75				
	WORCESTER PARK	5	7.6	7.95	0.35	8.3	5.9	4.1	0.03
	LAKE FINAL	10	13.8	17.15	3.35				
	EFFLUENT	15	16.6	25.45	8.85				
		20	23.15	30.2	7.05				
	WORCESTER PARK	5	6.5	6.8	0.3	4.7	0.65	0.07	0.05
	MAIN FINAL	10	12.45	14.9	2.45				
	EFFLUENT	15	16.6	20.2	3.6				
		20	21.1	23.8	2.7				

TABLE 10: B.O.D. OF RIVER MOLE SITES WITHOUT DILUTION WATER

MOLE SURVEY

DATE	SAMPLE	DILN X DAY (D)	BOD(ATU)	BOD	BOD - BOD(ATU)	NH3 DAY 0	NH3 DAY 5
6.11.90	KINNERSLEY	5	1.8	3.1	1.3	8.7	6.6
	MANOR	10	6.85	9.55	2.7		
	FLANCHFORD	5	1.65	3.65	2	5.1	1.9
	BRIDGE	10	6.5	12.15	5.65		
	RICE BRIDGE	5	0.65	2.5	1.85	4.8	2.3
		10	4.95	11.4	6.45		
	WONHAM MILLS	5	1.8	2.6	0.8	2.8	1.9
		10	5.7	9.5	3.8		
	BETCHWRTH	5	1.1	2.2	1.1	1.4	0.8
	BRIDGE	10	5.3	10.55	5.25		
	BROCKHAM	5	0.5	2.6	2.1	1.7	1.4
	BRIDGE	10	4.8	7.6	2.8		
	DEEPDENE	5	1.2	3.4	2.2	0.6	0.39
		10	4.4	7.6	3.2		

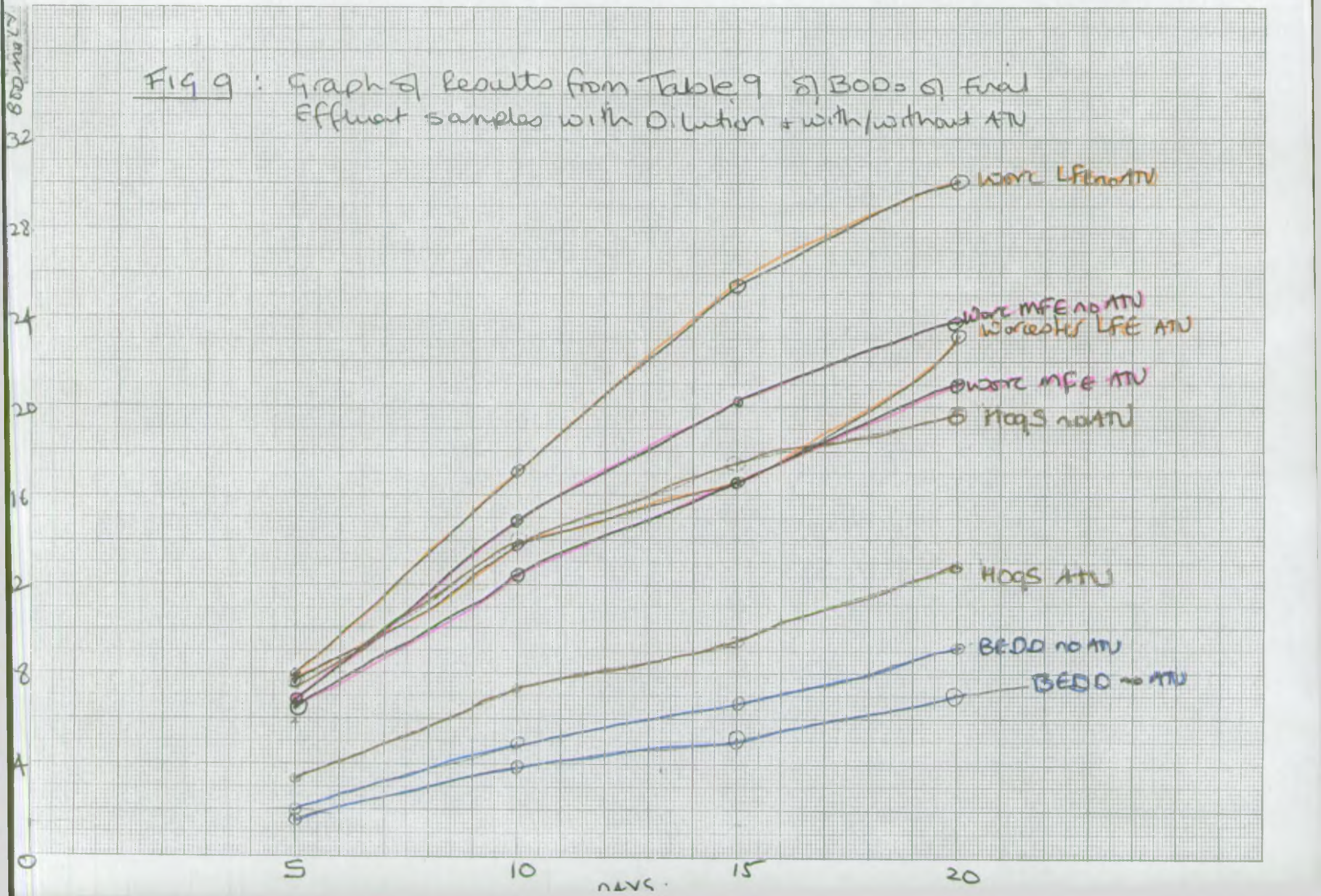


FIG 9 : Graph of Results from Table 9 of BOD5 of Final Effluent samples with Dilution + with/without ATU
BOD mg/l
32
28
24
20
16
12
8
4
0
5
10
15
20
DAYS
Worc LF no ATU
Worc MFE no ATU
Worcs LFE ATU
Worc MFE ATU
Hogs no ATU
Hogs ATU
BEDD no ATU
BEDD no ATU